AIR DISPERSION MODELING ASSESSMENT OF AIR TOXIC EMISSIONS FROM BNSF SAN DIEGO RAIL YARD

Submitted to:
California Air Resources Board

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ACRONYMS

ARB	Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BNSF	BNSF Railway Company
BPIP-PRIME	Building Profile Input Program – Plume Rise Model Enhancement
CalEPA	California Environmental Protection Agency
CalOSHA	California Occupational Safety and Health Administration
CARDS	Comprehensive Aerological Reference Dataset
DPM	Diesel particulate matter
ENVIRON	ENVIRON International Corporation
GE	General Electric
GIS	Geographic Information Systems
HD	Heavy-duty
HRA	Health Risk Assessment
I	Interstate
ISC	Industrial Source Complex
IGRA	Integrated Global Radiosonde Archive
LD	Light-duty
MATES	Multiple Air Toxics Exposure Study
MOU	Memorandum of Understanding
MTBE	Methyl t-butyl ether
NAS	Naval Air Station
NCDC	National Climactic Data Center
NLCD	National Land Cover Data
NRC	National Research Council
NWS	National Weather Service
OEHHA	Office of Environmental Health Hazard Assessment
PM	Particulate matter
PMI	Point of maximum impact
POLA	Port of Los Angeles
POLB	Port of Long Beach
RAAC	Risk Assessment Advisory Committee
SCRAM	Support Center for Regulatory Atmospheric Modeling
TAC	Toxic Air Contaminant
ULSD	Ultra low sulfur diesel
UPRR	Union Pacific Railroad Company

USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VMT	Vehicle miles traveled
WBAN	Weather Bureau Army Navy

ABREVIATIONS

%	percent
AERMAP	AERMOD Terrain Processor
AERMET	AERMOD Meteorological Preprocessor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
COOP	Cooperative Station (NWS)
kg	kilogram
km	Kilometer
L	liter
m^3	cubic meter
µg	microgram

1.0 INTRODUCTION

In June 2005, BNSF Railway Company (BNSF) and Union Pacific Railroad Company (UPRR) entered into a mutual agreement (ARB/Railroad Statewide Agreement, 2005b or the "Agreement") with the California Air Resources Board (ARB) to reduce particulate emissions from their respective rail yards that are owned and operated within the State of California. Under provisions of the Agreement, ARB staff will be performing Health Risk Assessments (HRAs) at 17 rail yards ("Designated Rail Yards") within California. The HRAs will consider emissions of toxic air contaminants (TACs) from emission sources at each Designated Rail Yard including resident and transient locomotives, on- and off-road equipment, and stationary equipment.

Generally, an HRA consists of three major parts: (1) an air emissions inventory for TAC emission sources, (2) air dispersion modeling to evaluate off-site airborne concentrations due to TAC emissions from these sources, and (3) the assessment of risks associated with these predicted airborne concentrations. The UPRR and BNSF are required to complete the first two parts of the risk assessment process under the Agreement. Under the MOU, ARB will conduct the assessment of risks part of the HRA process using the results of air dispersion exposure analyses conducted for each Designated Rail Yard. As noted in the MOU, specific objectives of these risk assessments include developing a basis for risk mitigation and risk communication, including developing information to place the estimated risks in appropriate context. To aid in developing information for risk communication, ARB will also be conducting health risk assessments for other significant sources of TACs within the vicinity of each Designated Rail Yard.

BNSF has retained ENVIRON International Corporation (ENVIRON) to assist it with the development of TAC emissions inventories and in conducting the air dispersion modeling for each of their Designated Rail Yards. Under the current draft Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities (the "draft Guidelines", (ARB 2006a)), emission inventories and air dispersion modeling results for the following BNSF Designated Rail Yards were submitted in 2006: Commerce/Eastern Intermodal, Commerce/Mechanical, Los Angeles Intermodal (Hobart), Richmond, Stockton, and Watson/Wilmington (the "2006 BNSF Designated Rail Yards"). Emission inventories and air dispersion modeling results for the following BNSF Designated Rail Yards will be submitted in 2007: San Bernardino, Barstow, and San Diego (the "2007 BNSF Designated Rail Yards"). This report presents the methods and results of the air dispersion modeling analysis conducted to evaluate TAC emissions from operations at the San Diego Rail Yard located in San Diego, California ("San Diego").

1.1 Objectives

The purpose of this report is to summarize ENVIRON's methods used to conduct the air dispersion exposure assessment of TAC emissions from the BNSF San Diego Yard and to provide the results of this analysis to ARB for their completion of the HRA for this rail yard. As discussed in the draft Guidelines (ARB 2006a), the air dispersion modeling exposure assessment requires the selection of the dispersion model, the data that will be used in the dispersion model (pollutants to be modeled with appropriate averaging times, source characterization, building downwash, terrain, meteorology) and the identification of receptors whose potential exposure will be considered in ARB's HRA. ENVIRON previously provided to ARB a report that described ENVIRON's model selection, meteorological data selection, and meteorological data processing methodologies for all the 2007 BNSF Designated Rail Yards (ENVIRON 2007). ARB approved these aspects of the air dispersion modeling analysis on August 31, 2007.[1] The remainder of this introduction section summarizes ENVIRON's selection of the air dispersion model to provide the modeling context for the methods discussed in the remainder of this report.

1.2 Methodologies

As discussed in the draft Guidelines, "air dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source" (ARB 2006a). The Agreement currently requires that air dispersion modeling be performed to estimate airborne concentrations from the dispersion of TAC and particulate matter emissions from relevant sources at each Designated Rail Yard. The emissions of diesel particulate matter (DPM) are separated from other particulate related TAC emission data in the model input and output (ARB 2006a). Air dispersion modeling requires the selection of an appropriate dispersion model and input data based on regulatory guidance, common industry standards/practice, and/or professional judgment. In general, ENVIRON performed air dispersion modeling for the BNSF Designated Rail Yards consistent with previous studies and/or guidance documents prepared by ARB (ARB 2004, 2005a, 2005c, 2006a) and the United States Environmental Protection Agency (USEPA 2000, 2004a, 2004b, 2005a, 2005b).

ENVIRON used the latest American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD version 07026) to estimate airborne concentrations resulting from TAC emissions from the BNSF San Diego Yard. It should be noted that this version of AERMOD (i.e., version 07026) is an updated version to the version of the model used for the

[1] Personal communication, H. Holmes of ARB by e-mail to D. Daugherty of ENVIRON on August 31, 2007.

2006 BNSF Designated Yards (i.e., version 04300). AERMOD model was developed as a replacement for USEPA's Industrial Source Complex (ISC) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. Both models are near-field, steady-state Gaussian plume models, and use site-representative hourly surface and twice-daily upper air meteorological data to simulate the effects of dispersion of emissions from industrial-type releases (e.g., point, area, and volume) for distances of up to 50 kilometers (USEPA 2005b).

For the past 20 years, refined near-field air dispersion modeling has typically been conducted using USEPA's Industrial Source Complex (ISC) model. However, on November 9, 2005, the USEPA promulgated final revisions to the federal Guideline on Air Quality Models (USEPA 2005a). These revisions recommend that AERMOD, including the PRIME building downwash algorithms, be used for dispersion modeling evaluations of criteria air pollutant and toxic air pollutant emissions from typical industrial facilities. A one-year transition period occurred from November 9, 2005 to November 9, 2006. Following this transition period, all refined, near-field air dispersion modeling following EPA guidance is required to use AERMOD. AERMOD provides better characterization of plume dispersion than does ISC, according to USEPA (USEPA 2003). AERMOD also is the model recommended by ARB in the draft Guidelines (ARB 2006a).

1.3 Report Organization

This report is divided into six sections as follows:

Section 1.0 – Introduction: describes the purpose and scope of this report and outlines the report organization.

Section 2.0 – Site Description: provides a brief description of the San Diego Facility and its operations.

Section 3.0 – Emission Inventory Summary: summarizes the TAC emission inventory results that were previously submitted to ARB under a separate report.

Section 4.0 – Air Dispersion Modeling: describes the air dispersion modeling methods used to estimate air chemical concentrations.

Section 5.0 –Uncertainties: summarizes some of the uncertainties resulting from various assumptions used in the air dispersion evaluation as well as from those used in the emission inventory development.

Section 6.0 – References: includes all references cited in this report.

The appendices include supporting information as follows:

Appendix A: provides the tables of hourly, daily, and seasonal temporal information for source activities

Appendix B: provides the electronic SCREEN3 input and output files for plume rise adjustments for locomotive movement activities

Appendix C: provides the electronic AERMOD-ready meteorological data files and raw surface and upper air meteorological data files

Appendix D: provides the electronic building downwash input and output files

Appendix E: provides the electronic digital elevation model (DEM) files

Appendix F: provides the electronic shapefiles containing census data for the San Diego area

Appendix G: discusses the sensitivity analysis used to determine the spacing and extents of the receptor grids

Appendix H: provides the electronic input and output files for AERMOD

Appendix I: provides the air concentration results in a Microsoft Access database, the methodology for the calculation of air concentrations, and the electronic database files and queries used to perform the calculations

2.0 SITE HISTORY

The San Diego site description incorporated in this evaluation is based primarily on information provided by BNSF and its contractors' staff. The following information is included to facilitate understanding of this site's operations as evaluated by this work.

2.1 Site Setting and Description

The BNSF San Diego Rail Yard is located at 1342 Cesar Chavez Parkway in San Diego, California, in downtown San Diego. As shown in Figure 2-1, the BNSF San Diego Yard is located in a commercial and industrial area, with several residential areas located within three kilometers. The BNSF San Diego Yard is bordered by East Harbor Drive to the north, Cesar Chavez Parkway to the east, Crosby Road and Water Street to the south, and industrial areas to the west. The BNSF San Diego Rail Yard is also located within two kilometers of three other major roadways, including: Interstate 5 (I-5) to the north and east, Highway 94 to the north and east, and Highway 75 to the south. Figure 2-2 depicts available land use data from the United States Geological Survey's (USGS's) National Land Cover Dataset (USGS 2006) within 20 kilometers (km) of San Diego, as required by the draft Guidelines (ARB 2006a). Table 2-1 summarizes the percentage of each land use category within this 20-km radius.

Due to the small size of the San Diego Rail Yard, the Yard is not divided into distinct operating areas. The main rail line for through traffic runs parallel to the northern boundary of the BNSF San Diego Yard, however, because East Harbor Drive separates the main line from the BNSF San Diego Yard, rail activities on the main line were not included in the air dispersion analysis for the San Diego Yard, as per the draft Guidelines.

2.2 Facility Operations

Activities at San Diego include locomotive refueling and switching, line-haul locomotives, track maintenance equipment, on-road refueling trucks, and transportation refrigeration units (TRUs). The approximate locations of these activities at the Facility are shown in Figures 2-3 through 2-6.

As indicated above, due to the relatively small size of the Facility, emission activities are not divided into distinct operating areas. These emission activities, described in further detail in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008), occurring at the San Diego Yard are outlined below:

Facility Emission Activities

A. Locomotive Refueling
D. Switching
E. Arriving-Departing Line-Haul
I. On-Road Refueling Trucks
K1. Boxcar/Freight TRUs
K2. Track Maintenance

Locomotive refueling occurs via direct-to-locomotive (DTL) transfer from on-road refueling trucks in two areas at the Facility. Locomotive idling occurs during the refueling process, which occurs directly from trucks and only in the locomotive refueling area. Locomotives may enter and exit the refueling areas from any tracks within the Yard, as indicated in Figure 2-3.

Locomotives may arrive and depart from both the east and west ends of the Facility and may be switched onto any rail line within the Facility, as indicated in Figure 2-5. Locomotive switching activities at the San Diego Yard include both switching (i.e., unhooking and moving rail cars from existing trains) and train make-up (i.e., configuring new trains). Locomotive switching activities occur in four distinct areas of the Yard, labeled as switching areas “A”, “B”, “C”, and “D”, as indicated in Figure 2-4. Train make-up activities can occur anywhere in the Yard except in the switching areas, as shown in Figure 2-4.

On-road container trucks and refueling trucks enter and exit the facility on from the main ingress/egress on Cesar Chavez Parkway. The locations of truck idling activity at the entrance and exit gates are indicated in Figure 2-3. On-road fueling trucks travel along the southern boundary of the Facility to the two DTL refueling locations, as indicated in Figure 2-3.

Track maintenance and boxcar/freight TRU activities may occur anywhere where locomotive activities occur, as shown in Figure 2-6.

3.0 EMISSION INVENTORY SUMMARY

ENVIRON estimated emissions for BNSF San Diego Yard activities and provided this to ARB (ENVIRON 2008). The methodology used to calculate the DPM and gasoline TAC emission factors were described in this submission to ARB. Detailed calculation methodologies and the resulting emission factors are also included. The remainder of this section provides a brief summary of the San Diego activities for which TAC emissions were estimated.

3.1 Locomotive DPM Emissions

ENVIRON described San Diego locomotive operations by dividing the emissions activities into three emissions categories:

A. Locomotive Refueling
D. Switching
E. Arriving and Departing Trains

Category designations (i.e., A, D, and E) for each locomotive activity were assigned in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008).

From data provided by BNSF and through discussions with BNSF operations staff, ENVIRON determined the overall activity of locomotive operations. The locomotive operations data included the number of engines and the typical time in notch setting for those engines active at the facility. ENVIRON inferred locomotive movements and time in engine notch settings based on information provided by BNSF. ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008) provides a detailed description of the information and estimates used to define operations and resulting emissions within activity categories A, D, and E. Temporal emission profiles were developed for locomotive activities based on operating schedules provided by BNSF. Variable hourly emission factors were applied in the air dispersion modeling to approximate the temporal variations in emissions from locomotive activities, as discussed in Section 4.3. These temporal emission factors are presented in electronic tables in Appendix A.

3.2 DPM Emissions from On-Road Refueling Trucks

On-road refueling trucks (designated as activity category I) included refueling trucks that deliver fuel to the locomotives in the locomotive refueling areas. DPM emissions due to on-road refueling truck travel at San Diego were estimated using emission factors from the draft

EMFAC2005 model provided by ARB (2006c) and an average on-site travel distance. On-road refueling truck counts at the facility entrance and exit gates, entrance and exit queuing time (used in the calculation of idling emissions at the entrance and exit gates), and average speed and distance on site were determined from a sample chase truck study at the San Diego Yard. Additional details regarding the emission calculation methodologies are discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008).

3.3 DPM and Gasoline TAC Emissions from Off-Road Equipment

ENVIRON categorized off-road equipment at the Facility into two main types of equipment: TRUs and track maintenance equipment (designated as activity category K). TRUs are used to regulate temperatures during the transport of products with temperature requirements. For BNSF operations at San Diego, temperatures are regulated by TRUs in boxcars and freight cars when the material being shipped requires such temperature regulation. TRU emissions were estimated using the draft version of the OFFROAD model provided by ARB (2006c). TRU yearly activity was estimated using the time onsite by TRU configuration (either railcar or freight car) and mode of transport. This activity data was used along with ARB default age, horsepower, and load factor input estimates in the OFFROAD model to estimate TRU emissions. An additional factor of 0.6 was used to account for the temporary use of TRU units. All TRUs are assumed to use diesel fuel. Additional details regarding the emission calculation methodologies are discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008).

Track maintenance equipment included equipment used to service tracks and included a variety of large and small engines and equipment. BNSF California track maintenance equipment can be used on any or all tracks within California to maintain the network. Therefore, DPM and gasoline TAC emissions for a given facility were estimated by apportioning the sum of emissions from all track maintenance equipment in California by site using the relative track mileage (including all tracks, main line and other tracks) at the site to the California total track mileage. Total exhaust emissions from track maintenance equipment were estimated using the draft version of the OFFROAD model (ARB 2006c). Additional details regarding the emission calculation methodologies are discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008).

3.4 Emission Estimates Summary

Tables 3-1a and 3-1b summarize the total annual emissions, operating hours, and the emission rate (in grams per second or grams per square meter per second) for each emission source by activity subcategory for DPM and gasoline emission sources, respectively. ENVIRON performed the air dispersion modeling to estimate period-average DPM and gasoline concentrations using χ/Q emission rates (i.e., one gram per second per source for point and volume sources and one gram per second divided by the total surface area of the source group for each area source), resulting in period-average dispersion factors. Tables 3-1a and 3-1b include the emission rates (in grams per second) applied to the period-average dispersion factors from the air dispersion model to calculate period-average air concentrations. ENVIRON performed air dispersion modeling to estimate hourly maximum gasoline concentrations using maximum hourly TOG emission rates. Table 3-1b also includes the maximum hourly TOG emission rates for gasoline sources used to estimate maximum one-hour TAC concentrations.

Table 3-2 outlines the annual DPM and TAC emissions estimated for each of the main source categories described in this section and their contribution to the total DPM and gasoline TOG and PM emissions. The emissions for each of the activities were distributed spatially and temporally over the range of operations as described in more detail in Section 4.

4.0 AIR DISPERSION MODELING

ENVIRON performed air dispersion modeling to estimate exposure concentrations from the dispersion of DPM and TAC emissions from routine operational sources at San Diego. ENVIRON evaluated DPM emissions from locomotive and on- and off-road diesel engines as well as TAC emissions from gasoline engines. Air dispersion modeling requires the selection of an appropriate dispersion model and input data based on regulatory guidance, common industry standards/practice, and/or professional judgment. As stated previously, ENVIRON performed air dispersion modeling generally consistent with previous studies and guidance documents (ARB 2004, 2005a, 2005c, 2006a and USEPA 2000, 2004a, 2004b, 2005a, 2005b) based on the information available at the time of the assessment. The type of air dispersion model and modeling inputs (i.e., pollutants to be modeled with appropriate averaging times, source characterization and parameters, meteorological data, building downwash, terrain, land use, and receptor locations) that ENVIRON used in the air dispersion modeling for San Diego are discussed below.

4.1 Model Selection and Model Control Options

As discussed in the Introduction, ENVIRON used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD version 07026) to estimate airborne concentrations resulting from DPM and TAC emissions from the BNSF San Diego Yard as recommended in the draft Guidelines (ARB 2006a) and USEPA air dispersion modeling guidelines (2005b). AERMOD was developed as a replacement for USEPA's Industrial Source Complex (ISC) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. This change was made in November 2005 (USEPA 2005a). Starting in November 2006, ISC was no longer considered a USEPA-approved model for certain regulatory applications. Both models are near-field, steady-state Gaussian plume models, and use site-representative hourly surface and twice-daily upper air meteorological data to simulate the effects of dispersion of emissions from industrial-type releases (e.g., point, area, and volume) for distances of up to 50 kilometers (USEPA 2005b).

AERMOD is appropriate for use in estimating ground-level short-term ambient air concentrations resulting from non-reactive buoyant emissions from sources located in simple and complex terrain. ENVIRON conducted the air dispersion analysis using AERMOD in the regulatory default mode, which includes the following modeling control options:

- adjusting stack heights for stack-tip downwash (except for building downwash cases),

- incorporating the effects of elevated terrain,
- employing the calms processing routine, and
- employing the missing data processing routine.

4.2 Modeled Pollutants and Averaging Periods

Calculation of chemical concentrations for use in exposure analysis requires the selection of appropriate concentration averaging times. ENVIRON based the selection of appropriate averaging times on the toxicity criteria data developed by the California Environmental Protection Agency (CalEPA).

For DPM, CalEPA has developed toxicity criteria for both carcinogenic and chronic non-carcinogenic effects (CalEPA 2005a, 2005b). Therefore, ENVIRON estimated the period-average DPM concentration over the span of the meteorological data for ARB's use in estimating cancer and chronic non-cancer risk. ENVIRON did not calculate maximum short-term concentrations (one-hour averages) for DPM as an acute toxicity criteria for DPM has not been developed by the CalEPA (i.e., no acute reference exposure level (REL) is listed) (CalEPA 2000).

ENVIRON evaluated a large number of non-DPM TACs in this assessment from non-DPM sources (mainly from gasoline engine emissions) as identified in the speciation profiles discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008). ENVIRON estimated both annual-average and maximum one-hour concentrations for each non-DPM TAC. In order to substantially reduce modeling complexity and run time, maximum one-hour TOG exhaust, TOG evaporative, and PM exhaust emission rates (as opposed to maximum one-hour individual TAC emission rates) were input into the air dispersion model. Speciation profiles containing the fractions of individual TACs for TOG exhaust, TOG evaporative, and PM exhaust emissions, discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008), were then applied to the TOG exhaust, TOG evaporative, and PM exhaust concentrations estimated by the dispersion model to calculate concentrations of individual TACs. This methodology resulted in conservative estimates (i.e., over-predictions) of the maximum one-hour concentrations for individual TACs.

4.3 Source Characterization and Parameters

Source characterization, location, and parameter information is necessary to model the dispersion of air emissions. ENVIRON modeled DPM and other TAC emissions from operational sources at San Diego, as described above. In general, ENVIRON determined source locations from the activity information discussed in Section 2, facility plot plans, information provided by BNSF personnel and contractors, and/or recent aerial photographs of the facility and surrounding areas. ENVIRON accounted for temporal (i.e., hourly, daily, and/or seasonal) variations in activities and emissions from each source by using variable hourly, daily, and seasonal emission factors where available. ENVIRON represented emissions from locomotive sources, vehicular sources, and mobile equipment sources as one of the following source types, and generally consistent with the draft Guidelines (ARB 2006a), where possible:

- Point source (a source with emissions emanating from a known point, with buoyancy due to either thermal or mechanical momentum). A point source is characterized by a height, diameter, temperature, and exit velocity.
- Volume source (a source with emissions that have no buoyancy and are emanated from a diffuse area). A volume source is characterized by an initial lateral and vertical dimension (initial dispersion) and a release height.
- Area source (a source with emissions that have no buoyancy and are emanated from a diffuse plane or box). An initial vertical dimension and release height may also be specified for an area source.

ENVIRON used point sources to model emissions from stationary idling locomotive source activities. ENVIRON used volume sources to represent emissions from moving sources along specific pathways (e.g., moving locomotives, trucks, and off-road equipment). ENVIRON used area sources to represent emissions from mobile equipment and vehicles operating over large areas. Additional details regarding the characterization of sources, source locations, and modeling parameters for each source category discussed in Section 3.0 are described below.

4.3.1 Locomotives at the Facility

4.3.1.1 Stationary Idling Locomotives

ENVIRON represented DPM emissions from stationary locomotive refueling, switching, and arriving-departing line-haul activities by point sources spaced approximately every 50 meters similar to ARB's Roseville Study (ARB 2004). ENVIRON placed point sources along railway lines at San Diego in areas where stationary idling activities occur, staggering point sources on adjacent parallel railway lines. The locations of point sources representing stationary locomotive activities are shown in Figures 4-1a through 4-1c. ENVIRON distributed emissions uniformly among the point sources comprising each stationary idling activity. Based on information from BNSF personnel, ENVIRON assumed that emissions from stationary locomotive switching and arriving-departing line haul activities occur 24 hours per day, seven days per week. Locomotive idling while refueling generally occurs 12 hours per day and seven days per week. A detailed temporal profile for the locomotive idling while refueling activity is presented in Appendix A. Table 3-1a summarizes the emissions and operating hours for each stationary locomotive activity. Variable hourly, daily, and seasonal emission factors were also applied to approximate the temporal variations in emissions from these sources. These variable emission profiles are summarized in electronic tables in Appendix A.

Facility personnel provided source parameter information (i.e., release height, velocity, temperature, and diameter), which was based on the specific locomotive types for each stationary idling activity. ENVIRON performed fleet-averaging of locomotive source parameters as recommended by the draft Guidelines (ARB 2006a) to reduce the large number of potential sources (from approximately 274 to 90) related to the stationary locomotive activities at San Diego. Fleet-averaging of source parameters was performed by weighting the source parameters for each locomotive model type by the percentage of emissions from each locomotive model type for a given locomotive activity. Table 4-1 summarizes the fleet-average source parameters for stationary locomotive activities at San Diego.

4.3.1.2 Locomotive Movement

ENVIRON represented DPM emissions from locomotive movement activities, including switching and arriving-departing line-haul, by individual volume sources spaced approximately every 50 to 75 meters similar to ARB's Roseville Study (ARB 2004). ENVIRON placed sources along railway lines at San Diego where movement activities occur. Figures 4-2a and 4-2b show the locations of modeled volume (movement) sources at the Facility. ENVIRON distributed emissions evenly among the volume sources comprising arriving-departing line haul. Based on information from BNSF personnel, ENVIRON apportioned switching emissions into five sub-categories representing four switching areas in the yard (Switching "A", "B", "C", and "D") as well as the Train Make-Up Area. Figure 2-4 shows the breakdown of switching activities into these five sub-areas. Based on information from BNSF personnel, ENVIRON assumed that emissions from locomotive movement switching and arriving-departing line-haul occur 24 hours per day, seven days per week. Table 3-1a summarizes the emissions and operating hours for each locomotive movement activity. Variable hourly, daily, and seasonal emission factors were also applied to approximate the temporal variations in emissions from these sources. These variable emission profiles are summarized in electronic tables in Appendix A.

For locomotive movement sources occurring along single rail lines, ENVIRON set the length of side for each volume source equal to the width of the fleet-average locomotive. In order to reduce modeling complexity and decrease model run-times, and in order to reduce the number of volume sources required to represent multiple parallel rail lines, ENVIRON used larger volumes with the length of side equal to the combined width of the rail lines plus the width of a locomotive. Because switching movement activities in the "A", "B", "C", and "D" areas as well as Train Make-Up are distinct activities, source spacing was determined separately for each distinct source activity area. A source spacing of 50 meters was used in the "A", "B", "C", and "D" switching areas and a source spacing of 75 meters was used in the Train Make-Up area to maximize the coverage in each operating area without resulting in overlap of adjacent volume sources. Because arriving-departing line haul movement activities occur over a continuous set of rail lines stretching across the Facility, a uniform source spacing of 75 meters was used to represent arriving-departing line-haul activities. ENVIRON used a similar methodology (i.e., volumes with the length of side equal to the combined width of the rail lines plus the width of a locomotive) to represent converging or diverging rail lines, resulting in progressively smaller volumes as the rail lines converged and progressively larger volumes as rail lines diverged. ENVIRON performed sensitivity analyses to evaluate the use of a single set of larger volume sources versus multiple sets of smaller volume sources along multiple parallel rail lines and converging rail lines. These sensitivity analyses demonstrated that the use of larger volume sources with 50-meter source spacing generally resulted in receptor concentrations within five percent of the receptor concentrations predicted by the multiple sets of smaller volume sources and smaller source spacing. The results of these sensitivity analyses are discussed in more detail in Appendix C of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b). ENVIRON calculated the corresponding initial lateral dimension of each volume source from USEPA guidance (USEPA 2004b).

ARB accounted for buoyancy effects of exhaust from locomotive movement activities by calculating plume rise adjustments to the release height using USEPA's SCREEN3 model for all 11 different locomotive models considered in the study (ARB 2004). Due to variability in locomotive travel speeds, hourly wind speeds, and hourly stability class, a potentially large uncertainty is associated with these plume rise adjustments. ENVIRON also calculated plume rise adjustments to the release height using the

SCREEN3 model and a methodology similar to that of ARB (ARB 2004). Due to the uncertainty associated with variable locomotive speeds, hourly wind speeds, and hourly stability class, plume rise adjustments were calculated based on fleet-average locomotive parameters for individual locomotive activities. For source activities with multiple notch settings (e.g., locomotive switching), ENVIRON selected plume rise predictions based on fleet-average source parameters for the single notch setting with the highest percentage of activity emissions. For movement activities with a range of locomotive speeds, the wind speed in SCREEN3 was set equal to the maximum locomotive speed, resulting in lower, more conservative plume rise adjustments. ENVIRON calculated the corresponding initial lateral dimension of each volume source from USEPA (USEPA 2004b) guidance. Tables 4-1 and 4-2 summarize the modeling source parameters, approximate travel speeds, and plume rise adjustments used for locomotive movement sources at San Diego. Electronic SCREEN3 input and output files used to determine plume rise adjustments are attached in Appendix B.

4.3.2 On-Road Refueling Trucks

As described in Section 3.2, on-road refueling trucks included refueling trucks that deliver fuel to the locomotives in the DTL refueling areas. ENVIRON represented DPM emissions from on-road refueling trucks by a combination of volume and area sources as recommended by the draft Guidelines (ARB 2006a) and in discussions with ARB staff.[2] ENVIRON used volume sources to represent refueling truck travel along specific pathways within the Facility. ENVIRON used area sources to represent on-road refueling truck idling at the Facility ingress and egress and DTL refueling areas. The use of area sources to represent on-road refueling truck idling emissions at the Facility ingress and egress is different from previous BNSF Rail Yards (i.e., Commerce-Eastern, Hobart, and Richmond), which used volume sources. Because unit emission rates were used in the modeling analysis and all idling emissions from on-road refueling trucks at the Facility (i.e., at the Facility ingress/egress and in the DTL refueling areas) were grouped into a single source group, the consistent use of either volume or area sources was required for all operational areas. Because idling emissions in the DTL refueling areas occurred over areas without well-defined travel paths, area sources were selected for all refueling truck idling sources. If multiple source groups are needed to distinguish impacts from idling emissions in different operational areas of the Facility, the selection of source type(s) for idling emissions from on-road refueling trucks can be refined. The use of area sources instead of volume sources results in conservative (i.e., higher)

[2] Personal communication. Gavin Hoch of ENVIRON by telephone with Jing Yuan of ARB on August 24, 2006.

predicted concentrations. The locations of volume and area sources representing on-road refueling truck idling areas and travel pathways and areas are shown in Figure 4-3.

BNSF personnel provided idling emissions at the entrance and exit gates for on-road refueling trucks. Moreover, as explained in the BNSF San Diego TAC Emissions Inventory, ENVIRON was able to estimate on-road refueling truck emissions based on known travel paths to the two DTL refueling areas and frequency of visits to each refueling area. Movement emissions along a given travel path or idling within a given idling area were distributed uniformly. ENVIRON assumed that emissions from on-road refueling trucks occur 24 hours a day, seven days per week based on information from BNSF personnel. Table 3-1a summarizes the DPM emissions and operating hours for on-road container and refueling trucks.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for on-road refueling trucks was not available from BNSF personnel. Based on information from a previous ARB study (ARB 2000) and recommendations by ARB staff in 2006,[3] ENVIRON used a release height of 4.0 meters for on-road refueling truck idling and travel during the daytime (i.e., 6 a.m. to 6 p.m.) and a release height of 6.0 meters for nighttime (i.e., 6 p.m. to 6 a.m.) to account for plume rise. ENVIRON calculated the corresponding initial vertical dimension of each volume and area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for on-road refueling truck activities at San Diego.

4.3.3 Off-Road Equipment

4.3.3.1 Boxcar/Freight TRUs

As boxcar/freight TRUs may be located throughout the locomotive operating areas at the Facility, and as specific modeling source parameters were not available, ENVIRON conservatively represented DPM emissions from boxcar/freight TRUs by area sources as recommended by the draft Guidelines (ARB 2006a). ENVIRON placed area sources over areas where boxcar/freight TRU activities occur. According to BNSF facility personnel, boxcar/freight TRUs may be located anywhere where locomotive activities occur. The locations of area sources representing boxcar/freight TRUs are shown in Figure 4-4. Emissions were distributed uniformly throughout the locomotive operating

[3] Personal communication. Gavin Hoch of ENVIRON by telephone with Pingkuan Di of ARB on August 31, 2006.

areas based on information from BNSF personnel. ENVIRON assumed that emissions from boxcar/freight TRUs occur 24 hours per day, seven days per week, based on information from BNSF personnel. Table 3-1a summarizes the DPM emissions and operating hours for boxcar/freight TRUs at the Facility.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for boxcar/freight TRUs was not available from BNSF personnel. ENVIRON conservatively assumed the release height of a boxcar/freight TRU (1.0 meters) based on photographs of container TRUs, and did not account for the elevated release height for multiple, vertically stacked containers or the height of the base of the boxcar/freight TRUs above the ground (i.e., the release height was based on the release point above the base of the boxcar, not above the ground). This conservative assumption likely results in over-predictions of receptor concentrations. ENVIRON calculated the corresponding initial vertical dimension of each area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for boxcar/freight TRUs at San Diego.

4.3.3.2 Track Maintenance Equipment

As track maintenance equipment operations may occur over all rail lines at the facility (i.e., over the switching, arriving-departing line-haul, and locomotive refueling areas), and as specific modeling source parameters were not available for track maintenance equipment, ENVIRON conservatively represented DPM and gasoline TAC emissions from track maintenance equipment over larger areas (i.e., over the switching, arriving-departing line-haul, and locomotive refueling areas) by area sources as recommended by the draft Guidelines (ARB 2006a). ENVIRON placed area sources over rail lines where track maintenance activities occur. The locations of area sources representing track maintenance equipment are shown in Figure 4-5. ENVIRON assumed that track maintenance equipment emissions were spread uniformly over all rail lines throughout the Facility. ENVIRON assumed that emissions from track maintenance activities occur weekdays (i.e., Monday through Friday) from 7 a.m. to 7 p.m. based on information from BNSF personnel. Tables 3-1a and 3-1b summarize the DPM and gasoline emissions, respectively, and operating hours for track maintenance equipment.

Model-specific source parameter information (i.e., release height, velocity, temperature, and diameter) for track maintenance equipment was not available from BNSF personnel. Because track maintenance equipment generally appeared to be similar in height to locomotives and have vertical emissions releases, ENVIRON assumed an average release height corresponding to the lowest moving locomotive release height adjusted for plume rise (i.e., the lowest adjusted release height in Table 4-2). ENVIRON calculated the corresponding initial vertical dimension of each area source from USEPA (USEPA 2004b) guidance. Table 4-3 summarizes the modeling source parameters for track maintenance equipment activities at San Diego.

4.4 Meteorological Data

AERMOD requires a meteorological input file to characterize the transport and dispersion of pollutants in the atmosphere. Surface and upper air meteorological data inputs as well as surface parameter data describing the land use and surface characteristics near the site are first processed using AERMET, the meteorological preprocessor to AERMOD. The output file generated by AERMET is the meteorological input file required by AERMOD. Details of AERMET and AERMOD meteorological data needs are described in USEPA guidance documents (USEPA 2004a, 2004b). As ENVIRON previous received ARB approval of meteorological data selection and processing methods (ENVIRON 2006a), the remainder of this section only briefly describes the following two key aspects of the AERMET analysis: the surface and upper air meteorological data selected and the surface parameter evaluation for San Diego. ENVIRON has provided the raw meteorological data and the AERMOD model-ready meteorological data files as an electronic attachment in Appendix C.

4.4.1 Surface and Upper Air Meteorological Data

The focus of the HRA to be conducted by ARB is the characterization of risk in the areas immediately surrounding the San Diego Yard. As such, ENVIRON selected meteorological data for air dispersion modeling based upon their spatial and temporal representativeness of conditions in the immediate vicinity of the rail yard. As described in ENVIRON's report on meteorological data selection and processing methods previous approved by ARB (ENVIRON 2007), ENVIRON selected the wind speed, wind direction, and temperature data from the CARB-operated San Diego-Beardsley station for the year from 2006 as the most representative available wind speed, wind direction, and temperature data for use in the air dispersion analysis of the BNSF San Diego Rail Yard. ENVIRON used cloud cover and pressure data (as San Diego-Beardsley did not collect pressure measurements in 2006) from the National Weather Service's (NWS's) San Diego Lindbergh Field for 2006. Upper air data from the San Diego Miramar Naval Air Station (NAS) was used in AERMET processing for the San Diego Yard (ENVIRON 2007).

4.4.2 Surface Parameters

Prior to running AERMET, it is necessary to specify the surface characteristics for the meteorological monitoring site and/or the project area. The surface parameters include surface roughness, Albedo, and Bowen ratio, and are used to compute fluxes and stability of the atmosphere (USEPA 2004a) and require the evaluation of nearby land use and temporal impacts on these surface parameters. Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site (i.e., San Diego-Beardsley meteorological station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB.[4] Because the selected meteorological station is in very close proximity to the San Diego Yard (within 0.5 kilometers) and the land use surrounding the meteorological station is very similar to the land use surrounding the San Diego Yard, surface parameters calculated for the meteorological station should be representative of the San Diego Yard.

In general, ENVIRON determined land-use sectors around the San Diego station using USGS land cover maps in conjunction with recent aerial photographs. ENVIRON then specified surface parameters for each using default seasonal values adjusted for the local climate. When a land-use sector consists of multiple land use types, ENVIRON used an area-weighted average of each surface parameter as recommended by USEPA (2004a). When a land-use sector consisted of multiple land-use types, ENVIRON, in general, used an area-weighted average of each surface parameter as recommended by USEPA (2004a) with a few exceptions as noted below. Because of the meteorological monitoring station's proximity to the shoreline, ENVIRON made additional considerations of the appropriateness of using default methods in assigning surface roughness to sectors surrounding the facility. The locale-specific surface parameters used in this evaluation were described in ENVIRON's previous report to ARB (ENVIRON 2007).

In general, default land-use analysis is performed such that concentrations estimated in a sector downwind of a source are based on surface characteristics upwind from the source. However, for shoreline sources, sectors can be comprised of both land and water, where land-use types can vary by a few orders of magnitude in surface roughness. The assignment of surface parameters to such a mixed-use sector containing significant amounts of both land and water based on upwind surface characteristics can significantly over- or under-predict concentrations depending on the configuration of the land-use, source, and receptors. The approach adopted in "Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites" (Hanna and Britter 2002) only

[4] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

includes the effects of roughness downwind of the source, because the distance to achieve a new equilibrium boundary layer is typically much less than distances of interest. Thus, for the San Diego Yard, ENVIRON performed an evaluation of the assignment of upwind or downwind land-use patterns for each sector as recommended by Hanna and Britter (2002).

Figure 4-6 shows the sectors ENVIRON defined around San Diego Beardsley for use in the AERMET processing and the USEPA land-use types within each sector. Before assigning surface parameters for each sector, ENVIRON evaluated the appropriateness of using land-use characteristics upwind of the source for estimating concentrations downwind of the source:

- **Sector 1:** Concentrations estimated in Sector 1 are based on winds flowing from Sector 5. Sector 5 has large amounts of water while Sector 1 is almost entirely urban in land use. Since the surface roughness differences between the upwind and downwind sectors are potentially more than two orders of magnitude in difference, concentrations in Sector 1 could be significantly overestimated if concentrations in these sectors were estimated using land-use upwind of the source. Thus, land-use characteristics for concentrations estimated for Sector 1 are based on land-use downwind of the source using the methodology of Hanna and Britter (2002).
- **Sectors 2 and 8:** Concentrations estimated in Sectors 2 and 8 are based on winds flowing from Sectors 6 and 4, respectively. Sectors 6 and 4 have large amounts of water while Sectors 2 and 8 are largely urban in land use. Since the surface roughness differences between the upwind and downwind sectors are more than two orders of magnitude in difference, concentrations in Sectors 2 and 8 would be significantly overestimated if concentrations in these sectors were estimated using land-use upwind of the source. Thus, land-use characteristics for concentrations estimated for Sectors 2 and 8 are based on land-use downwind of the source using the methodology of Hanna and Britter (2002).
- **Sectors 3 and 7:** Concentrations estimated in Sectors 3 and 7 are based on winds flowing from Sectors 7 and 3, respectively. Sectors 3 and 7 are both largely urban in land use and contain small areas of water. The water-land configurations of both sectors both show land on the inner part of the sectors, while the outer portions have significant amounts of water. Thus, winds traveling towards the receptors from the source will not have traveled over any water nor through surface roughness changes of two orders of magnitude. Hence, land-use parameters upwind of the source are used to calculate concentrations at receptors in Sectors 3 and 7 as per the default methodology.
- **Sector 4:** Concentrations estimated in Sector 4 are based on winds flowing from the Sector 8. Sector 4 has significant portions of water while Sector 8 is almost entirely

urban in land use. The water-land configuration in Sector 4 is such that the inner part of the sector is land, while the outer portion is primarily water, with some out-lying land. Thus, winds traveling towards the inner receptors from the source will not have traveled over any water nor through surface roughness changes of two orders of magnitude to meet the inner receptors. We are assuming receptors in Sector 4 are primarily at the inside of the Sector, and choose surface parameters to emphasize the accuracy for these inside receptors, since the small land mass at the outside of this sector is largely commercial and not residential. Using land-use parameters downwind of the source to calculate concentrations at receptors downwind of the source would inappropriately take into account the amount of water in Sector 4 and thus over-predict concentrations at land-based receptors. Hence, land-use parameters upwind of the source are used to calculate concentrations at receptors in Sector 4 as per the default methodology.

- **Sector comprised of Sub-sectors 5a through 5o [Assuming Hanna & Britter Distance-Weighted Analysis]:** Concentrations estimated in Sector 5 are based on winds flowing from the Sector 1. Sub-sectors 5a through 5o have significant portions of water while Sector 1 is almost entirely urban in land use. Receptors representing populations are likely to be located on the southwest corner of this area. Winds going to this portion will have traveled over a significant stretch of water before reaching these receptors. Thus, using upwind surface parameters to calculate concentrations for these receptors would significantly under-predict concentrations. Using downwind surface parameters to calculate concentrations for these receptors would take into account the water characteristics that the wind would travel across before reaching the receptors, as per the Hanna and Britter method (2002) discussed above.
- **Sector 6:** Concentrations estimated in Sector 6 are based on winds flowing from Sector 2. The water-land configuration in Sector 6 is such that the eastern part of the sector is land, while the western portion is significantly water. Thus, winds traveling west towards the receptor populations in the eastern edge of Sector 6 from the source will not have traveled over any water or through surface roughness changes of two orders of magnitude. Using land-use parameters downwind of the source to calculate concentrations at receptors downwind of the source would inappropriately take into account the significant amount of water in Sector 6 and thus significantly over-predict concentrations at land-based receptors. Hence, land-use parameters upwind of the source are used to calculate concentrations at receptors in Sector 6 as per the default methodology. We assume receptors representing populations occur at the inside of the sector, while land at the outside of the sector is primarily commercial and not residential.

Another consideration made for the San Diego Yard is that the division of the project area into radial sectors does not account for transitions in surface parameters that occur normal to the sector boundaries. Specifically, analyses of the effect of cross-wind transitions in surface roughness (the surface parameter that can influence AERMOD predicted airborne concentrations most significantly (ENVIRON 2005; Long 2004)), indicate that changes more than two orders of magnitude can result in significant over-estimates or under-estimates of concentrations (Hanna and Britter 2002). In such cases, applying a distance-weighted average based on zones defined in the radial direction from the project area can result in surface roughness estimates which, when used for dispersion modeling applications, produce more representative results. In practice, changes of several orders of magnitude in surface roughness most frequently occur in transitions between water and land. The sector comprised of sub-sectors 5a – 5o is the only sector in this analysis that has a significant transition in surface parameters that occurs normal to the sector boundaries and contains receptors such that concentrations predicted would be significantly impacted by this arrangement (i.e. downwind receptors). Thus, ENVIRON employed a distance-weighted average for the calculation of the surface roughness for this sector using methodology suggested by Hanna and Britter (2002) for sectors with surface roughness that varies a few orders of magnitude in the radial direction. Distance-weighting is not required for sectors that are relatively homogeneous or do not have surface roughness varying by a few orders of magnitude.

4.5 Building Downwash

Building downwash is the effect of structures on the dispersion of emissions from nearby point (stack) sources. As several point sources at the San Diego Yard were identified as adjacent to or nearby buildings, ENVIRON considered building downwash in this assessment. ENVIRON estimated building dimensions (i.e., location of building corners) based on information provided by BNSF personnel and contractors. ENVIRON used oblique aerial photographs and building heights from similar building types at other BNSF Yards to estimate building heights at the San Diego Yard. Figure 4-7 shows the buildings evaluated as part of the building downwash analysis at San Diego. ENVIRON input building dimension information, summarized in Table 4-5, into USEPA's Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) to account for potential building-induced aerodynamic downwash effects. The electronic input and output files for BPIP are provided in Appendix D. A sensitivity analysis was conducted in ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b) to estimate the impact of building downwash from locomotive engines on stationary locomotive sources. This sensitivity analysis indicated that, at receptor distances close to the sources (i.e., within 100 meters), building downwash may have a large impact on the modeled concentrations. However, at distances further away from the sources (i.e., 400 to 700 meters), receptor concentrations for model runs with and without building downwash were similar (i.e., within 10% of each other). Based on the results of the sensitivity analysis, and the uncertainty in placing structures corresponding to stationary locomotives in areas where stationary locomotives occur, and the inherent uncertainty in concentration predictions near to stationary and mobile sources, as discussed in Section 5.0, building downwash effects from stationary locomotives were not considered in this assessment. The results of the sensitivity analysis are discussed in more detail in the Appendix F of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b).

4.6 Terrain

Another important consideration in an air dispersion modeling analysis is whether the terrain in the modeling area is simple or complex (i.e., terrain above the effective height of the emission point). ENVIRON used the following USGS 7.5 Minute digital elevation model (DEMs) information to identify terrain heights within the modeling domain:

- La Jolla
- Imperial Beach
- Imperial Beach OE West
- National City
- Point Loma
- Point Loma OE West
- La Mesa

The electronic DEM files in the North American Datum (NAD) 1983 projection are provided in Appendix E. ENVIRON provided terrain elevation data to the AERMOD model using version 07026 of AERMAP, AERMOD's terrain preprocessor.

4.7 Land Use

AERMOD can evaluate heat island effects from urban areas to atmospheric transport and dispersion using an urban boundary layer option. ENVIRON analyzed the urban nature of the area in the vicinity of the San Diego Rail Yard using two different methods: Auer's method and population density calculations. The Auer method of classifying land use calls for analysis of the land within a three-kilometer radius from the primary project area to determine if the majority of the land can be classified as either rural (i.e. undeveloped) or urban (Auer 1978). If more than fifty percent of the area circumscribed by this three-kilometer radius circle consists of Auer land-use industrial, commercial or residential urban land types, then the urban boundary layer option is used in modeling. ENVIRON used both the USGS National Land Cover Data and the most recent USGS aerial photograph of the area surrounding the facility to determine that more than fifty percent of the area within three kilometers of San Diego Yard is urban, see Figure 4-8a. Consistent with AERMOD guidance (USEPA 2005a), ENVIRON also used population density calculations to determine whether the urban boundary layer option would be appropriate for BNSF San Diego. USEPA guidance calls for analysis of the population density within a three-kilometer radius from the primary project area to determine if the land can be classified as an urban (i.e., the average population density is greater than 750 people/km^2). Using year 2000 census data (Geolytics 2001), ENVIRON determined that the average population density for the area within three kilometers of the San Diego Yard is greater than 750 people/km^2 (see Figure 4-8b and Table 4-6) and that the area in the vicinity of the San Diego Yard should be considered urban. Based on the results of the Auer analysis and the population density analysis, ENVIRON selected the urban boundary layer option.

Selection of the urban boundary layer option in AERMOD requires also requires an estimate of the population of the urban area in order to make adjustments to the urban boundary layer. ENVIRON used published census data for the City of San Diego to determine the population (i.e., 1,266,753 people) as recommended by USEPA (USEPA 2005a). ENVIRON also provides electronic census data for the modeling domain (described in the next section) as an electronic attachment in Appendix F, as required in the draft Guidelines.

4.8 Receptor Locations

ENVIRON used gridded receptor points surrounding the BNSF San Diego Yard in the air dispersion analysis. These gridded receptor points represent the general population in the vicinity of the BNSF San Diego Yard, which includes both residential and commercial populations. However, these receptors do not necessarily represent the specific locations of the residential and commercial populations in the vicinity of the BNSF San Diego Yard. ENVIRON used three sets of discrete Cartesian receptor grid points around the Facility in the air dispersion modeling. The spacing and sizes of the Cartesian receptor grids were determined based on a screening sensitivity analysis, discussed in more detail in Appendix G. The Cartesian receptors included a fine receptor grid with spacing of 50 meters out to a distance of approximately 500 meters from the Facility boundary, a medium receptor grid with spacing of 250 meters out to a distance of approximately 1,500 meters from the Facility boundary, and a coarse receptor grid with spacing of 500 meters out to approximately five kilometers from the Facility boundary. ENVIRON used Facility plot plans and other information provided by BNSF facility personnel to locate the Facility boundary. Receptors inside the facility boundary were removed prior to the air dispersion modeling analysis. The locations of the coarse, medium, and fine receptor grid points are shown in Figures 4-9a, 4-9b, and 4-9c, respectively. Discrete receptor points were generated from each of the grids shown in Figures 4-9a, 4-9b, and 4-9c. The air dispersion modeling analysis did not include receptors at the Facility boundary.

In accordance with the draft Guidelines (ARB 2006a), ENVIRON also evaluated individual receptor points at off-site locations within one mile of the Facility corresponding to sensitive receptors, including schools, hospitals, and daycare centers. Sensitive receptor locations were identified from searches of the following sources:

- California Department of Education, California School Directory
  http://www.cde.ca.gov/re/sd/
- The Automated Licensing Information and Report Tracking System (Hospitals and Licensed Care Facilities)
  http://alirts.oshpd.ca.gov/AdvSearch.aspx
- Yellow Pages
  http://yp.yahoo.com

These on-line databases were searched for the following zip codes in the city of San Diego:
92101 92102 92113 92118 92136

The sensitive receptor locations identified from the search of these data sources and within one mile of the Facility are listed in Table 4-7.

Electronic census data was provided for the modeling domain in accordance with the draft Guidelines (ARB 2006a). These data, provided on a census-block level, were obtained from the GeoLytics CensusCD 2000 (GeoLytics 2001), and provided in electronic shapefile format in Appendix F.

4.9 Air Dispersion Modeling Results

ENVIRON calculated the air concentration of each TAC at each of the receptor locations discussed in Section 4.8. ENVIRON modeled DPM and TAC sources using unit emission rates (i.e., one gram per second) to estimate period-average dispersion factors for DPM and TACs corresponding to meteorological year 2006. These period-average dispersion factors for DPM and TACs were combined with source-specific emission rates to generate period-average concentrations for the meteorological year 2006. ENVIRON also modeled all non-DPM TAC sources using hourly-maximum evaporative TOG, exhaust TOG, and exhaust PM emission rates in order to estimate one-hour maximum evaporative TOG, exhaust TOG, and exhaust PM concentrations for the meteorological year 2006. ARB speciation profiles for evaporative TOG, exhaust TOG, and exhaust PM were applied to estimate chemical-specific one-hour maximum concentrations at each receptor. It should be noted that this method results in an over-prediction of maximum one-hour concentrations of individual constituents at each receptor, as discussed in the uncertainty section below. Electronic AERMOD input and output modeling files are included in Appendix H. The methodology used to calculate period-average DPM and gasoline TAC air concentrations and hourly-maximum gasoline TAC air concentrations, and the electronic database tables used in these calculations are provided in Appendix I. Appendix I also contains the electronic database tables containing DPM and gasoline TAC period-average concentrations at each receptor and one-hour maximum gasoline TAC concentrations at each receptor for the modeled meteorological period modeled.

5.0 UNCERTAINTIES

Understanding the degree of uncertainty associated with each component of a risk assessment is critical to interpreting the results of the risk assessment. As recommended by the National Research Council (NRC 1994), [a risk assessment should include] "a full and open discussion of uncertainties in the body of each EPA risk assessment, including prominent display of critical uncertainties in the risk characterization." The NRC (1994) further states that "when EPA reports estimates of risk to decision-makers and the public, it should present not only point estimates of risk, but also the sources and magnitude of uncertainty associated with these estimates." Similarly, recommendations to CalEPA on risk assessment practices and uncertainty analysis from the Risk Assessment Advisory Committee (RAAC) were adapted from NRC recommendations (RAAC 1996). Thus, to ensure an objective and balanced characterization of risk and to place the risk assessment results in the proper perspective, the results of a risk assessment should always be accompanied by a description of the uncertainties and critical assumptions that influence the key findings of the risk assessment.

In accordance with the recommendations described above and as required in the draft Guidelines (ARB 2006a), ENVIRON has evaluated the uncertainties associated with the first two steps of an HRA: (1) emissions estimation and (2) air dispersion modeling. The uncertainties and critical assumptions associated with these steps are described below. Consistent with the Agreement, ARB will complete the third major part of the HRA which consists of estimating the risks for each of the designated rail yards and evaluating the uncertainties associated with the risk characterization component of the HRA (ARB 2005b). As noted in the Agreement, specific objectives of the HRAs to be conducted by ARB include developing a basis for risk communication, including describing the uncertainties associated with the key findings of the risk assessment. At the request of ARB, ENVIRON will assist ARB in identifying the critical assumptions and uncertainties associated with the risk characterization step of the HRA. This uncertainty evaluation will be conducted concurrent with the ARB risk characterization activities and will be provided to ARB in a separate submittal.

The following section summarizes the critical uncertainties associated with the emissions estimation and air dispersion modeling components of the risk assessment.

5.1 Estimation of Emissions

The uncertainties associated with emissions estimates and projections include uncertainties in activity and emission rates for the base year as well as projected future years. Although future year emissions were not evaluated in this assessment, the residential and worker risk scenarios will be evaluated for 70-year and 40-year periods, respectively, at a minimum by ARB. Thus, uncertainty due to future changes in activity and emission rates will be generally discussed. The uncertainty in activity and emissions estimates applies to both locomotive and non-locomotive sources.

For locomotive sources, the activity rates include primarily the number of engines operating and time in modes. The number of engines operating in the facility and on the main line are accurately measured and counted at readers, but the readers are not necessarily located exactly at the site under study, and can under certain circumstances produce erroneous duplicate readings that could only be accounted for via rough approximation. A separate and less accurate dataset was used to estimate the number of engines arriving and departing from a site. These data, however, often do not produce matching arrivals and departures. ENVIRON adopted a conservative approach based on using the higher of the arrival or departure numbers, which may have resulted in overestimates of the number of engines arriving.

Uncertainties also exist in estimates of the engine time in mode. Idling is typically the most significant operational mode, but locomotive event recorder data could not distinguish between idling with the engine on and idling with the engine off. As a result, ENVIRON used professional judgment to distinguish between these two modes. In addition, no idle time reduction was assumed in the future year scenarios, despite the fact that BNSF has initiated programs to reduce idling through installation of automatic start/stop devices and other operational changes to reduce idling. So while the current operations may not be precisely known, control measures already being implemented are expected to result in reduced activity levels and lower emissions than are estimated here for future years.

The most significant non-locomotive sources at the San Diego Facility are track maintenance equipment and transportation refrigeration units. Activity levels of this equipment are estimated relatively accurately, however the duty cycles (engine load demanded) are less well characterized. Default estimates of the duty cycle may not accurately reflect the typical duty demanded from this equipment at the San Diego Facility. New emissions models for these sources have recently been provided for use in this study by ARB. In many cases, these revised models reflect a dramatic change in emission factors from previous versions of the models and it is therefore reasonable to expect that future revisions to these models may result in further changes to emission estimates for off-road engines. In addition, national and state regulations have targeted these sources for emission reductions. Implementation of these rules and fleet turnover to newer engines meeting more strict standards should significantly reduce emissions at these rail sites in future years. The effects of these regulations have, for the most part, not been incorporated in the emission estimates, and so estimated emissions are greater than those expected for future years at the same activity level.

5.2 Estimation of Exposure Concentrations

5.2.1 Estimates from Air Dispersion Models

As discussed in Section 4.0, USEPA-recommended dispersion model AERMOD was used to estimate annual average off-site chemical exposure concentrations at the various off-site receptor locations. This model uses the Gaussian plume equation to calculate ambient air concentrations from emission sources. For this model, the magnitude of error for the maximum concentration is estimated to range from 10 to 40% (USEPA 2005b). Therefore, off-site exposure concentrations used in this assessment represent approximate off-site exposure concentrations.

5.2.2 Source Placement

Uncertainty exists in the placement of emission sources at the Facility. As a large amount of locomotive and on- and off-road engine activity at a rail yard is engaged in movement, the distribution of emissions during movement in the yards is an important source of uncertainty. Unlike fixed stationary sources, emissions from movement would occur over a continuum rather than as discrete points. However, regulatory approved models were originally developed for the evaluation of fixed stationary sources and the use of a continuum of source locations to model emissions during movement of sources results in an unacceptably large number (in the tens of thousands) of sources that would result in unwieldy post-processing data needs and unacceptable modeling run times (on the order of months rather than hours or days).

In this assessment, most point and volume sources were spaced evenly at approximately 50-meter intervals, similar to ARB's Roseville Study (ARB 2004) over rail locations where locomotive and on- and off-road activities occurred. Closer spacing between point and volume sources may impact the predicted concentrations at receptor locations near the Facility boundary. Sensitivity analyses performed to determine the potential impact of source placement on predicted concentrations at receptors near the Facility boundary (see Appendix C of ENVIRON's BNSF Commerce/Mechanical Report [ENVIRON 2006b]) indicated that concentrations at receptors nearest to the specific emission sources could be over-predicted by at least 10 percent.

5.2.3 Source Representation

The source parameters (i.e., release velocity and release temperature) used to model stationary locomotive activities are sources of uncertainty. Following ARB guidance (ARB 2006a), fleet-average source parameters were calculated to reduce the large number of potential source parameter configurations related to stationary locomotive activities at the San Diego Yard. The specific methodology used for calculating fleet-averaged source parameters is presented in Section 4.3.1.1. The use of fleet-average source parameters for stationary locomotive activities resulted in approximate predictions for these sources.

The release heights and vertical dimensions used for movement sources at the Facility are also sources of uncertainty. ARB calculated adjustments to the release height and vertical dimension for movement sources for individual engine models based on locomotive notch settings (i.e., locomotive travel speeds) and using two different stability classes for their Roseville study (ARB 2004). This methodology resulted in several uncertainties. ARB's methodology assumed that the wind speed was equal to the locomotive speed and did not account for variability in either the locomotive speed or hourly wind speeds. In addition, ARB's methodology assumed only two stability classes (i.e., class "D" for daytime and class "F" for nighttime), and did not account for potential variability in stability class during these time periods based local meteorological data. Nevertheless, ENVIRON calculated plume rise adjustments using a methodology similar to ARB's, described in more detail in Section 4.3.1.2, for locomotive movement activities and on-road diesel and gasoline vehicle movement sources at the Facility. Thus, the use of plume rise adjustments resulted in approximate predictions of receptor concentrations for these sources.

The use of area sources to represent emissions sources operating in areas where travel paths are not well defined or equipment usage may occur over the entire operating area are additional sources of uncertainty related to source representation. At the BNSF San Diego Yard, area sources were used to represent transportation refrigeration units, on-road refueling truck idling, and track maintenance equipment, which account for approximately two percent of total DPM emissions from the Rail Yard. Based on guidance in the draft Guidelines (ARB 2006a), these source activities may be modeled as either area or volume sources. The AERMOD model uses very different methodologies to estimate dispersion from area and volume sources (USEPA 2004c), and the use of area sources generally results in higher (more conservative) concentration estimates. Thus, the use of area sources to represent transportation refrigeration units, on-road refueling truck idling, and track maintenance equipment at San Diego generally resulted in over-predictions of receptor concentrations for these source activities.

5.2.4 Meteorological Data Selection

Uncertainty also exists in the meteorological data used in the AERMOD air dispersion model. These uncertainties are related to the use of meteorological data that is not site-specific, combination of surface data from two meteorological stations, substitution of missing meteorological data, and use of surface parameters for the meteorological station as opposed to the rail yard.

ENVIRON selected meteorological data for air dispersion modeling based upon their spatial and temporal representativeness of conditions in the immediate vicinity of the rail yard. On-site meteorological data was not available for the rail yard. Therefore, the meteorological data used in this analysis was based on surface meteorological data from ARB's Beardsley station (within 0.5 kilometers from the rail yard) and the NCDC/NWS station at San Diego Lindbergh Field (approximately five kilometers from the rail yard) and upper air data from San Diego-Miramar Naval Air Station. A complete set of surface meteorological data was not available at ARB's San Diego-Beardsley station; therefore wind speed, wind direction, and temperature data from San Diego-Beardsley were combined with pressure and cloud cover data from San Diego Lindbergh Field. Meteorological surface measurements from the San Diego-Beardsley and San Diego Lindbergh Field stations were not 100% complete for all modeled years, therefore missing data were substituted using procedures outlined in Atkinson & Lee (1992). Surface parameters supplied to AERMET, the meteorological preprocessor to AERMOD, were specified for the area surrounding the meteorological monitoring site (San Diego-Beardsley station), rather than the project area (rail yard), as recommended by USEPA (USEPA 2005a) and ARB.[5] However, because the selected meteorological station is in very close proximity to the San Diego Yard and the land use surrounding the meteorological station is very similar to the land use surrounding the San Diego Yard, surface parameters calculated for the meteorological station should be representative of the San Diego Yard. The uncertainties due to the use of non-site-specific meteorological data, combination of surface data from different stations, substitution of missing surface data, and use of surface parameters for the meteorological station resulted in approximate exposure concentrations.

5.2.5 Building Downwash

The spacing and placement of point sources relative to buildings or structures results in impacts to building downwash parameters and resulting modeling concentrations. Based on the results of ENVIRON's sensitivity analyses discussed in Appendix G of ENVIRON's BNSF

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[5] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

Commerce/Mechanical Report (ENVIRON 2006b), the uncertainty in placing locomotive structures in areas where stationary locomotives occur, and the fact that many of the stationary locomotive activities occur in the interior of the rail yard, ENVIRON did not include building downwash effects due to locomotives in this assessment. Also, because specific locations for most stationary locomotive activities were not available, point sources representing these activities were distributed evenly over the areas where these operations occurred, as described in Section 4.3.1.1. These assumptions and modeling techniques resulted in approximate predictions of receptor concentrations near the facility boundary, as described in further detail below.

5.2.6 Uncertainty in Points of Maximum Impact

Receptor concentration estimates in close proximity to the facility, such as any potential point of maximum impact (PMI), are highly dependent on air dispersion modeling assumptions. That is, different modeling assumptions regarding the spatial and temporal distributions of the emission sources can greatly influence the resulting concentration estimates in proximity to the emission sources, including the magnitude and location of the PMI. As discussed in Section 5.2.2, there is significant uncertainty associated with identification of and estimation of impacts at locations near to a mobile source facility due to the complexity associated with modeling sources that can move (i.e., volume or line sources representing mobile sources). The potential influence of modeling techniques used in this assessment were evaluated in a sensitivity analyses performed for two different movement activities at Commerce/Mechanical, presented in Appendix C of ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b). These two analyses illustrated the particular sensitivities in assessment of receptors near a rail yard's boundary to source representation (i.e., source spacing, and source sizing for approximation of mobile sources) in the modeling and how source simplification assumptions generally result in over-prediction of concentrations near to the rail yards. Other modeling techniques and assumptions used in this assessment, including fleet-averaging of stationary locomotive activity source parameters, plume rise adjustments to locomotive and on-road diesel and gasoline vehicle movement sources, the use of area sources to represent emissions sources operating in areas where travel paths are not well defined or equipment usage may occur over the entire area, as described above, also contribute to uncertainty to modeling predictions for receptors near the boundary of the rail yard.

Focusing on receptor locations at a greater distance (i.e., one to two kilometers) from the facility reduces the overall influence on the proximity to specific site operations. The two sensitivity analyses discussed above, and presented in more detail in ENVIRON's BNSF Commerce/Mechanical Report (ENVIRON 2006b), indicated that concentrations were over-predicted by 21% and 17% at the PMI. However, at distances one to two kilometers from the facility, receptor concentrations for the two source configurations were all within one to five percent of each other. Thus, the results of these two sensitivity analyses indicated that concentrations at receptors further from the sources are much less sensitive to air dispersion assumptions regarding the spatial and temporal distributions of emission sources.

5.2.7 Estimation of Maximum One-Hour TAC Concentrations

ENVIRON evaluated a large number of non-DPM TACs in this assessment from non-DPM sources (mainly from gasoline engine emissions) as identified in the speciation profiles discussed in ENVIRON's San Diego TAC Emissions Inventory (ENVIRON 2008). In order to substantially reduce modeling complexity and run time, maximum one-hour TOG exhaust, TOG evaporative, and PM exhaust emission rates (as opposed to maximum one-hour individual TAC emission rates) were input into the air dispersion model. Speciation profiles containing the fractions of individual TACs for TOG exhaust, TOG evaporative, and PM exhaust emissions (discussed in San Diego TAC Emissions Inventory) were then applied to the TOG exhaust, TOG evaporative, and PM exhaust concentrations estimated by the dispersion model to calculate concentrations of individual TACs. This methodology resulted in conservative estimates (i.e., over-predictions) of the maximum one-hour concentrations for individual TACs.

5.3 Risk Characterization

As stated previously, ARB will conduct the risk characterization part of the HRA based on the results of the emissions estimation and air dispersion modeling provided by ENVIRON. Consistent with the Agreement and draft Guidelines *(*ARB 2005b, 2006a), the risk characterization activities conducted by ARB will include evaluating and reporting the uncertainties associated with the estimated risks for each designated rail yard. As discussed in detail above, there are many uncertainties associated with the estimation of emissions and exposure point concentrations from rail yard emission sources that would be in addition to the uncertainties associated with the exposure assumptions and toxicity information to be used in ARB's estimation of risks. Many of these uncertainties lead to an over-prediction of the estimated offsite impacts. At the request of ARB, ENVIRON will assist ARB in identifying the critical assumptions and uncertainties associated with the risk characterization step of the HRA. This evaluation will be conducted concurrent with the ARB risk characterization activities and will be provided to ARB in a separate submittal.

6.0 REFERENCES

AERMOD; Version 04300 ed.; American Meteorological Society/ Environmental Protection Agency, version 04300.

Air Resources Board (ARB). 2000. *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles. Appendix VII: Risk Characterization Scenarios.* October.

Air Resources Board (ARB). 2004. Roseville Rail Yard Study. October 2004.

Air Resources Board (ARB). 2005a. ARB Comments on the Health Risk Assessment Protocol for Port of Los Angeles Terminal Improvement Projects. May 23.

Air Resources Board (ARB). 2005b. *ARB/Railroad Statewide Agreement, Particulate Emissions Reduction Program at California Rail Yar*ds. June.

Air Resources Board (ARB). 2005c. Draft Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach. October.

Air Resources Board (ARB). 2006a. Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities (Preliminary Draft). July.

Air Resources Board (ARB). 2006b. Quality Assurance Air Monitoring Site Information http://www.arb.ca.gov/qaweb/siteinfo.php

Air Resources Board (ARB). 2006c. Draft OFFROAD, and Draft EMFAC2005 models on disk. August, 2006. Cargo handling equipment emissions provided September 26, 2006.

Auer, Jr., A.H. Correlation of Land Use and Cover with Meteorological Anomalies. Journal of Applied Meteorology, 17:636-643, 1978.

California Air Pollution Control Officers Association (CAPCOA) Toxic Committee. 1997. Gasoline Service Station Industrywide Risk Assessment Guidelines. November.

California Environmental Protection Agency (CalEPA). 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August, 2003.

California Environmental Protection Agency (CalEPA). 2006. *Air Resources Board Speciation Profile Database*. Air Resources Board. Online. Updated January 11, 2006. Accessed: March 2006. Available: http://www.arb.ca.gov/ei/speciate/speciate.htm.

ENVIRON International Corporation. 2005. *Developing State-Wide Guidance for the Use of AERMOD – A Workgroup's Experience. Air and Waste Management Association Annual Fall Conference. Baton Rouge, LA.*

ENVIRON International Corporation (ENVIRON). 2006a. *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards.* August.

ENVIRON International Corporation (ENVIRON). 2006b. *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Mechanical Rail Yard.* October.

ENVIRON International Corporation (ENVIRON). 2006c. *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Richmond Rail Yard.* October.

ENVIRON International Corporation (ENVIRON). 2006d. *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Eastern Rail Yard.* November.

ENVIRON International Corporation (ENVIRON). 2007. *Meteorological Data Selection and Processing Methodology for 2007 BNSF Designated Rail Yards.* August.

ENVIRON International Corporation (ENVIRON). 2008. *San Diego TAC Emissions Inventory*. January.

ESRI ArcGIS Desktop; Environmental Systems Research Institute, version 9.2.

GeoLytics, Incorporated (GeoLytics). 2001. CensusCD 2000, Short Form Blocks, Release 1.0. Electronic census data.

G. E. Long; Cordova, J. F.; Tanrikulu, S. **2004**. *An Analysis of AERMOD Sensitivity to Input Parameters in the San Francisco Bay Area. 13th Conference on the Applications of Air Pollution Meteorology with the Air and Waste Management Association. Vancouver, B.C. Canada*.

S. R. Hanna; Britter, R. E. 2002. *Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites*; American Institute of Chemical Engineers: New York, New York.

National Research Council (NRC). 1994. *Science and Judgment in Risk Assessment.* National Academy Press, Washington, D.C.

Risk Assessment Advisory Committee (RAAC). 1996. *A Review of the California Environmental Protection Agency's Risk Assessment Practices, Policies, and Guidelines*. October.

South Coast Air Quality Management District (SCAQMD). 2000. *Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II).* March.

United States Environmental Protection Agency (D. Atkinson; Lee, R. F.). 1992. Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models. Research Triangle Park, NC. July 7.

United States Environmental Protection Agency (USEPA). 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA-454/R-99-005. 6-32. February.

United States Environmental Protection Agency (USEPA). 2002. *Technical Description of the Toxics Module for MOBILE 6.2 and Guidance on Its Use for Emission Inventory Preparation*. Air and Radiation. EPA420-R-02-029. November.

United States Environmental Protection Agency (USEPA). 2003. Comparison of Regulatory Design Concentrations; AERMOD vs. ISCST3, CTDMPLUS, ISC-PRIME. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/R-03-002. June.

United States Environmental Protection Agency (USEPA). 2004a. User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-002. 5-9, 4-49. November.

United States Environmental Protection Agency (USEPA). 2004b. User's Guide for the AMS/EPA Regulatory Model - AERMOD. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

United States Environmental Protection Agency (USEPA). 2005a. AERMOD Implementation Guide. Research Triangle Park, North Carolina. September 27.

United States Environmental Protection Agency (USEPA). 2005b. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. 40 CFR Part 51, Appendix W (Federal Register) 70216

United States Geological Survey (USGS). 2001. National Land Cover Dataset 2001 (NLCD 2001), http://www.mrlc.gov/mrlc2k_nlcd.asp

Table 2-1

Percentages of Land Use Categories Within Twenty Kilometers of Facility

BNSF San Diego Rail Yard

San Diego, California

Land Use Category [1]	Percentage (%)
Open Water	38.75%
Developed, Open Space	6.06%
Developed, Low Intensity	9.32%
Developed, Medium Intensity	24.96%
Developed, High Intensity	7.33%
Barren Land (Rock/Sand/Clay)	0.67%
Deciduous Forest	0.00%
Evergreen Forest	0.05%
Mixed Forest	0.09%
Shrub/Scrub	7.27%
Grassland/Herbaceous	3.64%
Pasture/Hay	0.03%
Cultivated Crops	0.31%
Woody Wetlands	0.42%
Emergent Herbaceous Wetlands	1.11%

Notes:

1. Land use data are based on National Land Cover Data 2001 from US Geological Survey.

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources
BNSF San Diego Rail Yard
San Diego, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[1]	Source Group in Database	Total Emissions (g)	Days of Operation per week[2]	Hours of Operation per day[2]	Hours of Operation per year	Modeled Area (m^2)	Total Emission Rate[3,4] (g/s) or ($g/m^2/s$)	Number of Modeled Sources[5]	Emission Rate Applied to Period-Average Dispersion Factors[6] (g/s)
Locomotives	A	Basic Locomotive Service	A1	Idling While Refueling	Point	Idle	A1I	A1I	4,149	7	12	4,380	--	1.32E-04	2	6.58E-05
	D	Switching	D1	Switching A	Point	Idle	D1I	D1I	18,971	7	24	8,760	--	6.02E-04	3	2.01E-04
					Volume	Notch 1	D1V	D1V1	120	7	24	8,760	--	3.79E-06	2	1.90E-06
					Volume	Notch 2	D1V	D1V2	238	7	24	8,760	--	7.54E-06	2	3.77E-06
					Volume	Notch 3	D1V	D1V3	192	7	24	8,760	--	6.09E-06	2	3.05E-06
					Volume	Notch 4	D1V	D1V4	358	7	24	8,760	--	1.14E-05	2	5.68E-06
					Volume	Notch 5	D1V	D1V5	139	7	24	8,760	--	4.41E-06	2	2.20E-06
					Volume	Notch 6	D1V	D1V6	83	7	24	8,760	--	2.63E-06	2	1.31E-06
					Volume	Notch 7	D1V	D1V7	47	7	24	8,760	--	1.49E-06	2	7.46E-07
					Volume	Notch 8	D1V	D1V8	247	7	24	8,760	--	7.83E-06	2	3.91E-06
			D2	Switching B	Point	Idle	D2I	D2I	26,559	7	24	8,760	--	8.42E-04	3	2.81E-04
					Volume	Notch 1	D2V	D2V1	167	7	24	8,760	--	5.31E-06	2	2.65E-06
					Volume	Notch 2	D2V	D2V2	333	7	24	8,760	--	1.06E-05	2	5.28E-06
					Volume	Notch 3	D2V	D2V3	269	7	24	8,760	--	8.53E-06	2	4.26E-06
					Volume	Notch 4	D2V	D2V4	501	7	24	8,760	--	1.59E-05	2	7.95E-06
					Volume	Notch 5	D2V	D2V5	195	7	24	8,760	--	6.17E-06	2	3.09E-06
					Volume	Notch 6	D2V	D2V6	116	7	24	8,760	--	3.68E-06	2	1.84E-06
					Volume	Notch 7	D2V	D2V7	66	7	24	8,760	--	2.09E-06	2	1.04E-06
					Volume	Notch 8	D2V	D2V8	346	7	24	8,760	--	1.10E-05	2	5.48E-06
			D3	Switching C	Point	Idle	D3I	D3I	11,383	7	24	8,760	--	3.61E-04	2	1.80E-04
					Volume	Notch 1	D3V	D3V1	72	7	24	8,760	--	2.27E-06	2	1.14E-06
					Volume	Notch 2	D3V	D3V2	143	7	24	8,760	--	4.52E-06	2	2.26E-06
					Volume	Notch 3	D3V	D3V3	115	7	24	8,760	--	3.65E-06	2	1.83E-06
					Volume	Notch 4	D3V	D3V4	215	7	24	8,760	--	6.81E-06	2	3.41E-06
					Volume	Notch 5	D3V	D3V5	83	7	24	8,760	--	2.65E-06	2	1.32E-06
					Volume	Notch 6	D3V	D3V6	50	7	24	8,760	--	1.58E-06	2	7.89E-07
					Volume	Notch 7	D3V	D3V7	28	7	24	8,760	--	8.95E-07	2	4.48E-07
					Volume	Notch 8	D3V	D3V8	148	7	24	8,760	--	4.70E-06	2	2.35E-06
			D4	Switching D	Point	Idle	D4I	D4I	11,383	7	24	8,760	--	3.61E-04	3	1.20E-04
					Volume	Notch 1	D4V	D4V1	72	7	24	8,760	--	2.27E-06	2	1.14E-06
					Volume	Notch 2	D4V	D4V2	143	7	24	8,760	--	4.52E-06	2	2.26E-06
					Volume	Notch 3	D4V	D4V3	115	7	24	8,760	--	3.65E-06	2	1.83E-06
					Volume	Notch 4	D4V	D4V4	215	7	24	8,760	--	6.81E-06	2	3.41E-06
					Volume	Notch 5	D4V	D4V5	83	7	24	8,760	--	2.65E-06	2	1.32E-06
					Volume	Notch 6	D4V	D4V6	50	7	24	8,760	--	1.58E-06	2	7.89E-07
					Volume	Notch 7	D4V	D4V7	28	7	24	8,760	--	8.95E-07	2	4.48E-07
					Volume	Notch 8	D4V	D4V8	148	7	24	8,760	--	4.70E-06	2	2.35E-06
			D5	Switching Train Make-Up	Point	Idle	D5I	D5I	69,719	7	24	8,760	--	2.21E-03	33	6.70E-05
					Volume	Notch 1	D5V	D5V1	439	7	24	8,760	--	1.39E-05	10	1.39E-06
					Volume	Notch 2	D5V	D5V2	874	7	24	8,760	--	2.77E-05	10	2.77E-06
					Volume	Notch 3	D5V	D5V3	706	7	24	8,760	--	2.24E-05	10	2.24E-06
					Volume	Notch 4	D5V	D5V4	1,316	7	24	8,760	--	4.17E-05	10	4.17E-06
					Volume	Notch 5	D5V	D5V5	511	7	24	8,760	--	1.62E-05	10	1.62E-06
					Volume	Notch 6	D5V	D5V6	305	7	24	8,760	--	9.66E-06	10	9.66E-07
					Volume	Notch 7	D5V	D5V7	173	7	24	8,760	--	5.48E-06	10	5.48E-07
					Volume	Notch 8	D5V	D5V8	907	7	24	8,760	--	2.88E-05	10	2.88E-06

Table 3-1a
Summary of Emissions and Operating Hours for Modeled DPM Emission Sources
BNSF San Diego Rail Yard
San Diego, California

Emission Source	Activity Category	Activity Category Description	Activity Sub-Category	Activity Sub-Category Description	Modeling Source Type	Operation Mode	Modeling Source Group[1]	Source Group in Database	Total Emissions (g)	Days of Operation per week[2]	Hours of Operation per day[2]	Hours of Operation per year	Modeled Area (m^2)	Total Emission Rate[3,4] (g/s) or ($g/m^2/s$)	Number of Modeled Sources[5]	Emission Rate Applied to Period-Average Dispersion Factors[6] (g/s)
Locomotives	E	Arriving and Departing Line Haul	E	BNSF Arriving-Deparing Line Haul	Point	Idle	EI	EI	737,176	7	24	8,760	--	2.34E-02	44	5.31E-04
					Volume	Dynamic Break	EV	EVD	2,740	7	24	8,760	--	8.69E-05	12	7.24E-06
					Volume	Notch1	EV	EV1	108,170	7	24	8,760	--	3.43E-03	12	2.86E-04
					Volume	Notch2	EV	EV2	171,174	7	24	8,760	--	5.43E-03	12	4.52E-04
					Volume	Notch3	EV	EV3	91,597	7	24	8,760	--	2.90E-03	12	2.42E-04
					Volume	Notch4	EV	EV4	43,250	7	24	8,760	--	1.37E-03	12	1.14E-04
					Volume	Notch5	EV	EV5	26,841	7	24	8,760	--	8.51E-04	12	7.09E-05
					Volume	Notch6	EV	EV6	8,027	7	24	8,760	--	2.55E-04	12	2.12E-05
					Volume	Notch7	EV	EV7	850	7	24	8,760	--	2.69E-05	12	2.25E-06
					Volume	Notch8	EV	EV8	139,576	7	24	8,760	--	4.43E-03	12	3.69E-04
On-Road Container Trucks	I	On-Road Refueling Trucks	I	On-Road Refueling Trucks	Volume	--	IV	IV	59	7	12	4,380	--	1.87E-06	9	2.07E-07
					Area	--	IA	IA	304	7	12	4,380	166	5.81E-08	--	9.62E-06
Off-Road Equipment	K	Other Off-Road Equipment	K1	Boxcar/Freight TRUs	Area	--	K1A	K1A	16,493	7	24	8,760	39,762	1.32E-08	--	5.23E-04
			K2	Track Maintenance	Area	--	K2A	K2A	14,304	5	12	3,129	39,762	1.14E-08	--	4.54E-04

Notes:
1. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
2. "Days of Operation per Week" and "Hours of Operation per Day" indicate general operating schedules. Exact days and hours of operation for each emission activity can be found in the detailed temporal profiles in Appendix A.
3. The "Total Emission Rate" is calculated based on the "Total Emissions" assuming 8760 hours of operation per year. The actual "Hours of Operation per Year" are taken into account in the temporal profiles and are not included in the calculations here to avoid double counting.
4. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources.
5. The "Number of Modeled Sources" refers to the sum of Chi/Q for each modeling source group, which is equal to the number of modeled sources.
6. The "Emission Rate Applied to Period-Average Dispersion Factors" is the emission rate applied to the modeled period-average dispersion factors for each source group to estimate air concentrations.
For point and volume sources, the "Emission Rate Applied to Period-Average Dispersion Factors" is equal to the Total Emission Rate" divided by the "Number of Modeled Emission Sources";
For area sources, the "Emission Rate Applied to Period-Average Dispersion Factors" is equal to the Total Emission Rate" multiplied by the modeled area.

Table 3-1b
Summary of Emissions and Operating Hours For Modeled Gasoline Emission Sources
BNSF San Diego Rail Yard
San Diego, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Modeling Source Group[1]	Total Emissions (g)	Days of Operation Per Week[2]	Hours of Operation Per Day[2]	Hours of Operation per year	Total Emission Rate[3,4] (g/s) or (g/m^2/s)	Number of Modeled Sources	Modeled Area (m^2)	Emission Rate Applied to Period-Average Dispersion Factors[5] (g/s)	Hourly Maximum Emission Rate[6] (g/s) or (g/m^2/s)
Gasoline PM (ARB Speciate Profile #400)												
K2A	Track Maintenance	Area	GASPM	11	7	12	8,760	8.93E-12	--	39,762	3.55E-07	8.93E-12
TOG Evaporative (ARB Speciate Profile #422)												
K1A	Boxcar/Freight TRU	Area	TOGEVAP	81,063	7	24	8,760	6.46E-08	--	39,762	2.57E-03	6.46E-08
K2A	Track Maintenance	Area		68	7	12	8,760	5.44E-11	--	39,762	2.16E-06	5.44E-11
TOG Exhaust (ARB Speciate Profile #2105)												
K2A	Track Maintenance	Area	TOGEXH	387	7	12	8,760	3.09E-10	--	39,762	1.23E-05	3.09E-10

Notes:
1. "Modeling Source Group" corresponds to the modeling source group name in the AERMOD input and output files.
2. "Days of Operation per Week" and "Hours of Operation per Day" indicate general operating schedules. Exact days and hours of operation for each emission activity can be found in the detailed temporal profiles in Appendix A.
3. The "Total Emission Rate" is calculated based on the "Total Emissions" assuming 8760 hours of operation per year. The actual "Hours of Operation per Year" are taken into account in the temporal profiles and are not included in the calculations here to avoid double-counting.
4. The "Total Emission Rate" units are "grams per second" for point and volume sources and "grams per meter squared per second" for area sources.
5. The "Emission Rate Applied to Period-Average Dispersion Factors" is the emission rate applied to the modeled period-average dispersion factors for each source group to estimate air concentrations. For point and volume sources, the "Emission Rate Applied to Period-Average Dispersion Factors" is equal to the Total Emission Rate" divided by the "Number of Modeled Emission Sources"; For area sources, the "Emission Rate Applied to Period-Average Dispersion Factors" is equal to the Total Emission Rate" multiplied by the modeled area.
6. The "Hourly Maximum Emission Rate" is the emission rate used in the air dispersion model. For point and volume sources, the "Hourly Maximum Emission Rate" is equal to the "Emission Rate Applied to Period-Average Dispersion Factors". For area sources, the "Hourly Maximum Emission Rate" is equal to the "Total Emission Rate".

Table 3-2
Summary of Activity Category Total Annual DPM and TOG Emissions at the Facility
BNSF San Diego Rail Yard
San Diego, California

Activity Category	Activity Category Description	Diesel			Gasoline								
		PM Emissions			PM Emissions			TOG Evaporative Emissions			TOG Exhaust Emissions		
		Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)	Grams	Metric Tons	Percentage (%)
A	Basic Services	4,149	0.00	0.3%	--	--	--	--	--	--	--	--	--
D	Locomotive Switching	148,369	0.15	9.8%	--	--	--	--	--	--	--	--	--
E	Arriving-Departing Line Haul	1,329,401	1.33	87.9%	--	--	--	--	--	--	--	--	--
I	On-Road Refueling Trucks	362	0.00	0.0%	--	--	--	--	--	--	--	--	--
K	Off-Road Equipment	30,797	0.03	2.0%	11	0.00	100%	81,131	0.08	100%	387	0.00	100%
	TOTAL	1,513,077	1.51	100%	11	0.00	100%	81,131	0.08	100%	387	0.00	100%

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF San Diego Rail Yard
San Diego, California

									Day		Night	
Activity Subcategory	**Activity Subcategory Description**	**Modeling Source Type**	**Operation Mode**	**Stack Height (m)**	**Exit Temperature (K)**	**Exit Velocity (m/s)**	**Exit Diameter (m)**	**Initial Lateral Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**
A1	Idling While Refueling	Point	Idle	4.52	385.45	4.83	0.56	--	--	--	--	--
D1	Switching A	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Notch 1	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 2	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 3	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 4	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 5	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 6	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 7	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
		Volume	Notch 8	--	--	--	--	2.33 - 3.26	37.76	8.78	37.30	8.67
D2	Switching B	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Notch 1	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 2	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 3	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 4	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 5	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 6	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 7	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
		Volume	Notch 8	--	--	--	--	2.33 - 5.12	37.76	8.78	37.30	8.67
D3	Switching C	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Notch 1	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 2	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 3	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 4	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 5	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 6	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 7	--	--	--	--	3.26	37.76	8.78	37.30	8.67
		Volume	Notch 8	--	--	--	--	3.26	37.76	8.78	37.30	8.67
D4	Switching D	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Notch 1	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 2	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 3	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 4	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 5	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 6	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 7	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
		Volume	Notch 8	--	--	--	--	1.86 - 3.72	37.76	8.78	37.30	8.67
D5	Switching Train Make-Up	Point	Idle	4.52	361.60	15.56	0.29	--	--	--	--	--
		Volume	Notch 1	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 2	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 3	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 4	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 5	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 6	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 7	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67
		Volume	Notch 8	--	--	--	--	3.26 - 11.16	37.76	8.78	37.30	8.67

Table 4-1
Fleet-Average Source Parameters for Locomotive Activities
BNSF San Diego Rail Yard
San Diego, California

									Day		Night	
Activity Subcategory	**Activity Subcategory Description**	**Modeling Source Type**	**Operation Mode**	**Stack Height (m)**	**Exit Temperature (K)**	**Exit Velocity (m/s)**	**Exit Diameter (m)**	**Initial Lateral Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Initial Vertical Dimension (m)**
E	BNSF Arriving-Deparing Line Haul	Point	Idle	4.52	385.45	4.83	0.56	--	--	--	--	--
		Volume	Dynamic Break	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch1	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch2	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch3	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch4	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch5	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch6	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch7	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62
		Volume	Notch8	--	--	--	--	2.33 - 11.16	4.76	1.11	11.25	2.62

Table 4-2
Plume Rise Adjustments for Locomotive Movement Sources[1]
BNSF San Diego Rail Yard
San Diego, California

Activity Subcategory	Activity Subcategory Description	Modeled Notch Setting[2]	Locomotive Speed (mph)	Locomotive Speed (m/s)	Modeled Locomotive Type	Plume Height[3] (m)			Initial Vertical Dimension (m)		
						Stability D	Stability F	Adjusted F[4]	Stability D	Stability F	Adjusted F[4]
D1	Switching A	4	5.00	2.24	GS	37.76	37.30	--	8.78	8.67	--
D2	Switching B	4	5.00	2.24	GS	37.76	37.30	--	8.78	8.67	--
D3	Switching C	4	5.00	2.24	GS	37.76	37.30	--	8.78	8.67	--
D4	Switching D	4	5.00	2.24	GS	37.76	37.30	--	8.78	8.67	--
D5	Switching Train Make-Up	4	5.00	2.24	GS	37.76	37.30	--	8.78	8.67	--
E	BNSF Arriving-Departing Line Haul	2	30.00	13.41	LH	4.76	20.51	11.25	1.11	4.77	2.62

Notes:
1. Plume rise calculated using USEPA's SCREEN3 model using methodology in ARB's Roseville Study (ARB 2004).
2. Due to sensitivity of plume rise to wind speed and locomotive speed, plume rise adjustments calculated for only one notch setting per source subactivity. For source subactivities with multiple notch settings, the source parameters for the notch setting with the greatest percentage of activity emissions were selected.
3. Plume Height = physical height of locomotive plus plume rise.
4. The maximum wind speed for stability category F in SCREEN3 is 4.0 m/s. For locomotive speeds (i.e., effective wind speeds) greater than 4.0 m/s, the plume rise for stability category F was adjusted according to the methodology in the ARB Roseville Study (ARB 2004): adjusted plume rise = plume rise x (1/locomotive speed)^(1/3)

Source:
1. Air Resources Board (ARB). 2004. Roseville Rail Yard Study. October 2004

Table 4-3
Source Parameters for On-Road Refueling Trucks and Off-Road Equipment
BNSF San Diego Rail Yard
San Diego, California

Activity Subcategory	Activity Subcategory Description	Modeling Source Type	Day		Night	
			Release Height[1] (m)	Initial Vertical Dimension[2] (m)	Release Height[1] (m)	Initial Vertical Dimension[2] (m)
I	On-Road Refueling Trucks	Volume	4.00	0.93	--	--
		Area	4.00	0.93	6.00	1.40
K1	Boxcar/Freight TRUs	Area	1.00	0.23	--	--
K2	Track Maintenance	Area	4.76	1.11	--	--

Notes:
1. Assumed release height for track maintenance equipment equal to the lowest plume height from plume rise adjusments for locomotive sources; assumed release height for portable engines equal to 0.6 meter based on ARB Risk Reduction Plan (ARB 2000) and recommendations from ARB staff.
2. Initial vertical dimension calculated as release height divided by 4 .3 based on USEPA guidance (USEPA 2004) for volume sources not on or adjacent to a building.

Sources:

1. Air Resources Board (ARB). 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles. Appendix VII: Risk Characterization Scenarios. October.
2. United States Environmental Protection Agency (USEPA). 2004. User's Guide for the AMS/EPA Regulatory Model - AERMOD. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

Table 4-4
Sector-Specific Surface Roughness, Bowen Ratio, and Albedo
BNSF San Diego Rail Yard
San Diego, California

Month	Sector No.	2006 Albedo	2006 Bowen Ratio	2006 Surface Roughness
Jan	1	0.17	3.04	0.22
Feb	1	0.14	0.78	0.22
Mar	1	0.14	0.78	0.22
Apr	1	0.15	1.53	0.22
May	1	0.15	1.53	0.22
Jun	1	0.15	1.53	0.22
Jul	1	0.16	1.53	0.22
Aug	1	0.16	1.53	0.22
Sep	1	0.16	1.53	0.22
Oct	1	0.16	1.53	0.22
Nov	1	0.17	3.04	0.22
Dec	1	0.17	3.04	0.22
Jan	2	0.18	4.00	1.00
Feb	2	0.14	1.00	1.00
Mar	2	0.14	1.00	1.00
Apr	2	0.16	2.00	1.00
May	2	0.16	2.00	1.00
Jun	2	0.16	2.00	1.00
Jul	2	0.17	2.00	1.00
Aug	2	0.17	2.00	1.00
Sep	2	0.17	2.00	1.00
Oct	2	0.17	2.00	1.00
Nov	2	0.18	4.00	1.00
Dec	2	0.18	4.00	1.00
Jan	3	0.34	6.29	1.56
Feb	3	0.27	1.60	1.56
Mar	3	0.27	1.60	1.56
Apr	3	0.29	3.17	1.56
May	3	0.29	3.17	1.56
Jun	3	0.29	3.17	1.56
Jul	3	0.32	3.17	1.56
Aug	3	0.32	3.17	1.56
Sep	3	0.32	3.17	1.56
Oct	3	0.32	3.17	1.56
Nov	3	0.34	6.29	1.56
Dec	3	0.34	6.29	1.56
Jan	4	0.18	4.03	0.99
Feb	4	0.14	1.01	0.99
Mar	4	0.14	1.01	0.99
Apr	4	0.16	2.01	0.99
May	4	0.16	2.01	0.99
Jun	4	0.16	2.01	0.99
Jul	4	0.17	2.02	0.99
Aug	4	0.17	2.02	0.99
Sep	4	0.17	2.02	0.99
Oct	4	0.17	2.02	0.99
Nov	4	0.18	4.03	0.99
Dec	4	0.18	4.03	0.99

Table 4-4
Sector-Specific Surface Roughness, Bowen Ratio, and Albedo
BNSF San Diego Rail Yard
San Diego, California

Month	Sector No.	2006		
		Albedo	Bowen Ratio	Surface Roughness
Jan	5	0.18	3.97	0.99
Feb		0.14	0.99	0.99
Mar		0.14	0.99	0.99
Apr		0.16	1.98	0.99
May		0.16	1.98	0.99
Jun		0.16	1.98	0.99
Jul		0.17	1.99	0.99
Aug		0.17	1.99	0.99
Sep		0.17	1.99	0.99
Oct		0.17	1.99	0.99
Nov		0.18	3.97	0.99
Dec		0.18	3.97	0.99
Jan	6	0.18	4.00	1.00
Feb		0.14	1.00	1.00
Mar		0.14	1.00	1.00
Apr		0.16	2.00	1.00
May		0.16	2.00	1.00
Jun		0.16	2.00	1.00
Jul		0.17	2.00	1.00
Aug		0.17	2.00	1.00
Sep		0.17	2.00	1.00
Oct		0.17	2.00	1.00
Nov		0.18	4.00	1.00
Dec		0.18	4.00	1.00
Jan	7	0.17	3.36	0.84
Feb		0.14	0.85	0.84
Mar		0.14	0.85	0.84
Apr		0.15	1.69	0.84
May		0.15	1.69	0.84
Jun		0.15	1.69	0.84
Jul		0.16	1.69	0.84
Aug		0.16	1.69	0.84
Sep		0.16	1.69	0.84
Oct		0.16	1.69	0.84
Nov		0.17	3.36	0.84
Dec		0.17	3.36	0.84

Table 4-5
Approximate Dimensions of Buildings at the Facility
BNSF San Diego Rail Yard
San Diego, California

Building/ Structure ID	Building Name	UTM X (m)	UTM Y (m)	Approximate Footprint Dimensions[1] (m)	Height[2] (m)
1	Trainmaster's Building	486093.69	3617831.32	36 m x 29 m	6.71
2	*unknown name*	486111.60	3617859.49	14 m x 20 m	4.57
3-1	*unknown name*	486073.23	3617743.88	16 m x 11 m	3.35
3-2	*unknown name*	486083.37	3617756.50	16 m x 6 m	4.57
4	*unknown name*	485755.63	3617921.80	6 m x 25 m	3.35
5a	Tank 5A	485720.29	3617845.40	22 m (diameter)	6.71
5b	Tank 5B	485747.27	3617841.35	22 m (diameter)	6.71
5c	Tank 5C	485774.25	3617838.72	22 m (diameter)	6.71
6	*unknown name*	485652.97	3618018.73	13 m x 47 m	6.71
7a	Tank 7A	485575.85	3618062.42	21 m (diameter)	13.41
7b	Tank 7B	485591.61	3618039.98	21 m (diameter)	13.41
8	Tanks 8	485550.31	3618051.92	18 m x 62 m	20.12

Notes:
1. Approximate footprint dimensions estimated based on aerial photograph of facility.
2. Building heights estimated based on previous yards and on aerial photograph of facility.

Table 4-6
Population Density Within Three Kilometers of the Facility
BNSF San Diego Rail Yard
San Diego, California

Location	Land Area Within 3 km (m^2)	Water Area Within 3 km (m^2)	Yard Area (m^2)	Total Population Within 3 km	Population Density (people/km^2)
San Diego, CA	34,991,029	37,300,871	45,826	95,692	1,325
USE URBAN BOUNDARY LAYER?					YES

Table 4-7
Locations of Sensitive Receptors Within One Mile of the Facility
BNSF San Diego Rail Yard
San Diego, California

Facility	Address	City	Type	UTM X	UTM Y
Memorial Academy Charter	2850 Logan Ave.	San Diego	Public School	487559.28	3617717.13
Youth Oppor. Unlimited Sec. (alter Ed.)	2716 Marcy Ave.	San Diego	Public School	487298.59	3617779.76
NHA Mercado Head Start Family Focused Center	2001 Newton Ave.	San Diego	Child Care	486494.00	3617861.30
Barrio Child Development Center	2138 Logan Ave.	San Diego	Child Care	486858.50	3617906.48
Burbank Elementary[1]	2146 Julian Ave.	San Diego	Public School	487016.94	3618075.44
Burbank State Preschool - School Readiness[1]	2146 Julian Ave.	San Diego	Child Care	487016.94	3618075.44
Perkins Elementary[1]	1770 Main Street	San Diego	Public School	486057.66	3618117.53
NHA Early Link - Perkins Head Start[1]	1770 Main Street	San Diego	Child Care	486057.66	3618117.53
Logan Elementary[1]	2875 Ocean View Blvd.	San Diego	Public School	487595.35	3618150.42
Logan Child Development Center[1]	2875 Ocean View Blvd.	San Diego	Child Care	487595.35	3618150.42
Logan State Preschool - School Readiness Program[1]	2875 Ocean View Blvd.	San Diego	Child Care	487595.35	3618150.42
NHA Early Link - Logan Avenue Head Start[1]	2875 Ocean View Blvd.	San Diego	Child Care	487595.35	3618150.42
Kidcare Express[1]	1809 National Ave.	San Diego	Hospital	486264.27	3618207.26
Kidcare Express II (Mobile Medica Unit)[1]	1809 National Ave.	San Diego	Hospital	486264.27	3618207.26
King/Chavez Academy Of Excellence Charter	735 Cesar E. Chavez Parkway	San Diego	Public School	486607.78	3618339.71
Teen Health Center	1643 Logan Ave.	San Diego	Hospital	486080.99	3618511.48
St. Vincent De Paul Village Family Health Center[1]	1501 Imperial Ave.	San Diego	Hospital	485917.65	3618729.54
St. Vincent De Paul Village Children's Program[1]	1501 Imperial Ave.	San Diego	Child Care	485917.65	3618729.54
25th Street Family Medicine	316 25th St.	San Diego	Hospital	486844.20	3619000.31
Sherman Elementary	450 24th St.	San Diego	Public School	486637.93	3619148.13
Sherman Heights Family Health Center	2391 Island Ave.	San Diego	Hospital	486650.66	3619205.98
NHA - Sherman Heights Community Head Start Center	2258 Island Ave.	San Diego	Child Care	486590.03	3619216.15
Our Lady's School	650 24th St.	San Diego	Private School	486634.96	3619385.26

Note:

1. Although addresses are identical, buildings are modeled as separate sources because they are different service types.

Sources:

Locations of sensitive receptors were obtained from the following databases:

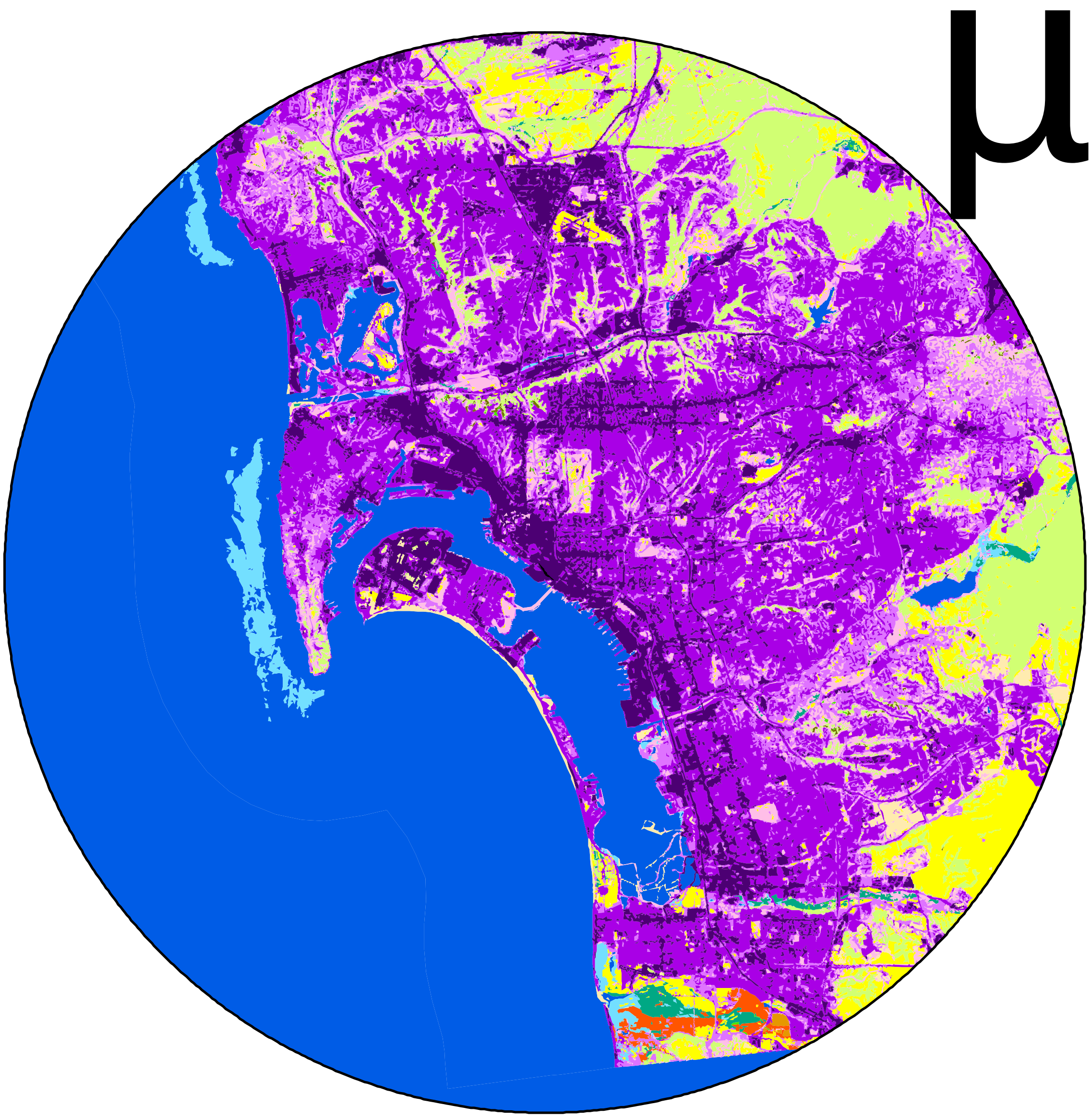
a. California Department of Education, California School Directory (http://www.cde.ca.gov/re/sd/)

b. The Automated Licensing Information and Report Tracking System(Hospitals and Licensed Care Facilities) (http://alirts.oshpd.ca.gov/AdvSearch.aspx)

c. Community Care Licensing Division, State of California (http://www.ccld.ca.gov/docs/ccld_search/ccld_search.aspx)

Figure 2-1: General Facility Location
BNSF San Diego Rail Yard
San Diego, California

Figure 2-2: Land Use Within Twenty Kilometers of Facility
BNSF San Diego Rail Yard
San Diego, California



Legend

Land Use Categories

- Barren Land (Rock/Sand/Clay)
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub
- Woody Wetlands
- San Diego Rail Yard

Kilometers

0 2 4 8 12 16

ENVIRON

Figure 2-3: Stationary Locomotive Refueling at DTL Areas and On-Road Refueling Truck Activities
BNSF San Diego Rail Yard
San Diego, California

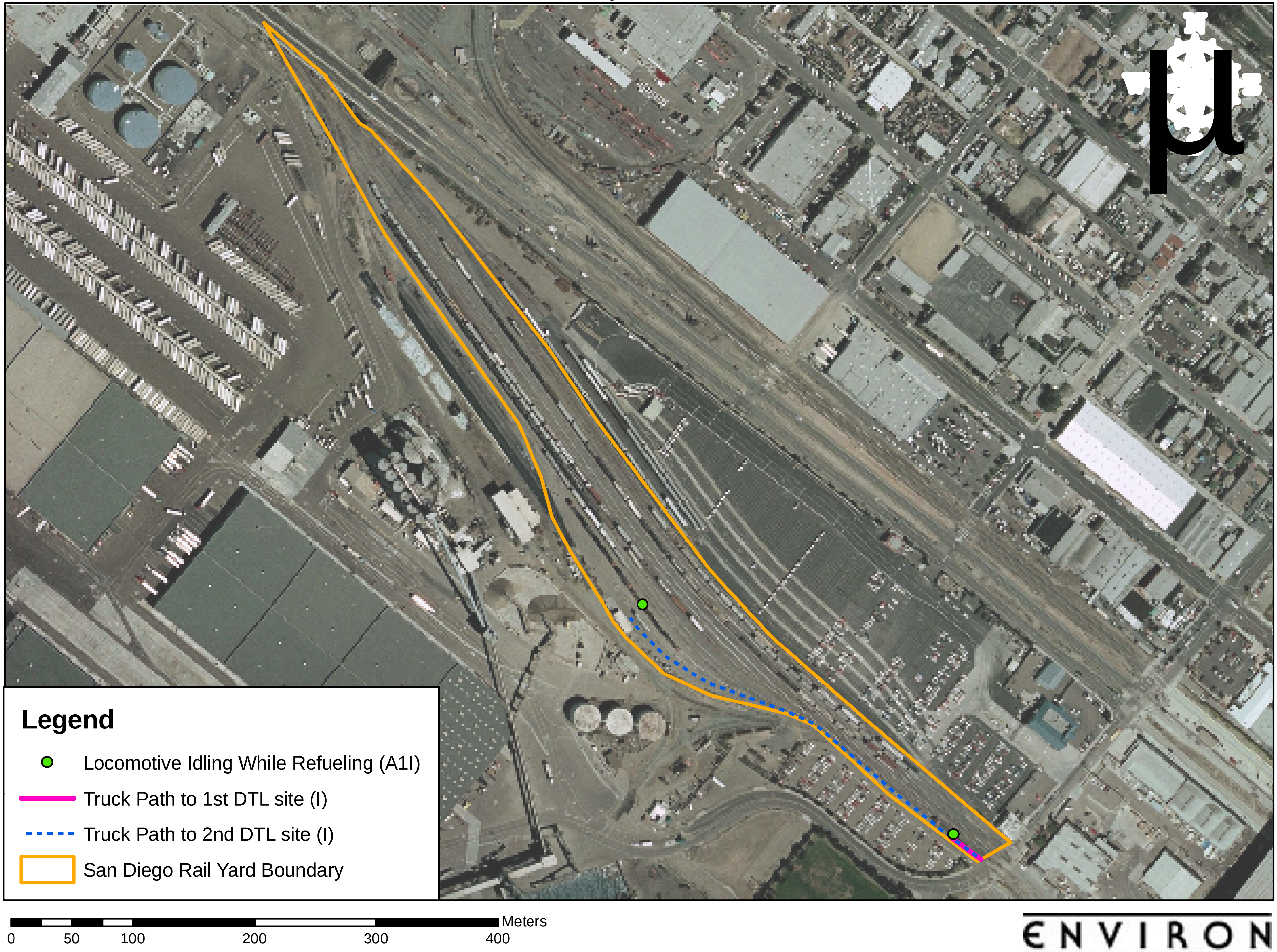


Figure 2-4: Stationary and Movement Locomotive Activities - Switching
BNSF San Diego Rail Yard
San Diego, California

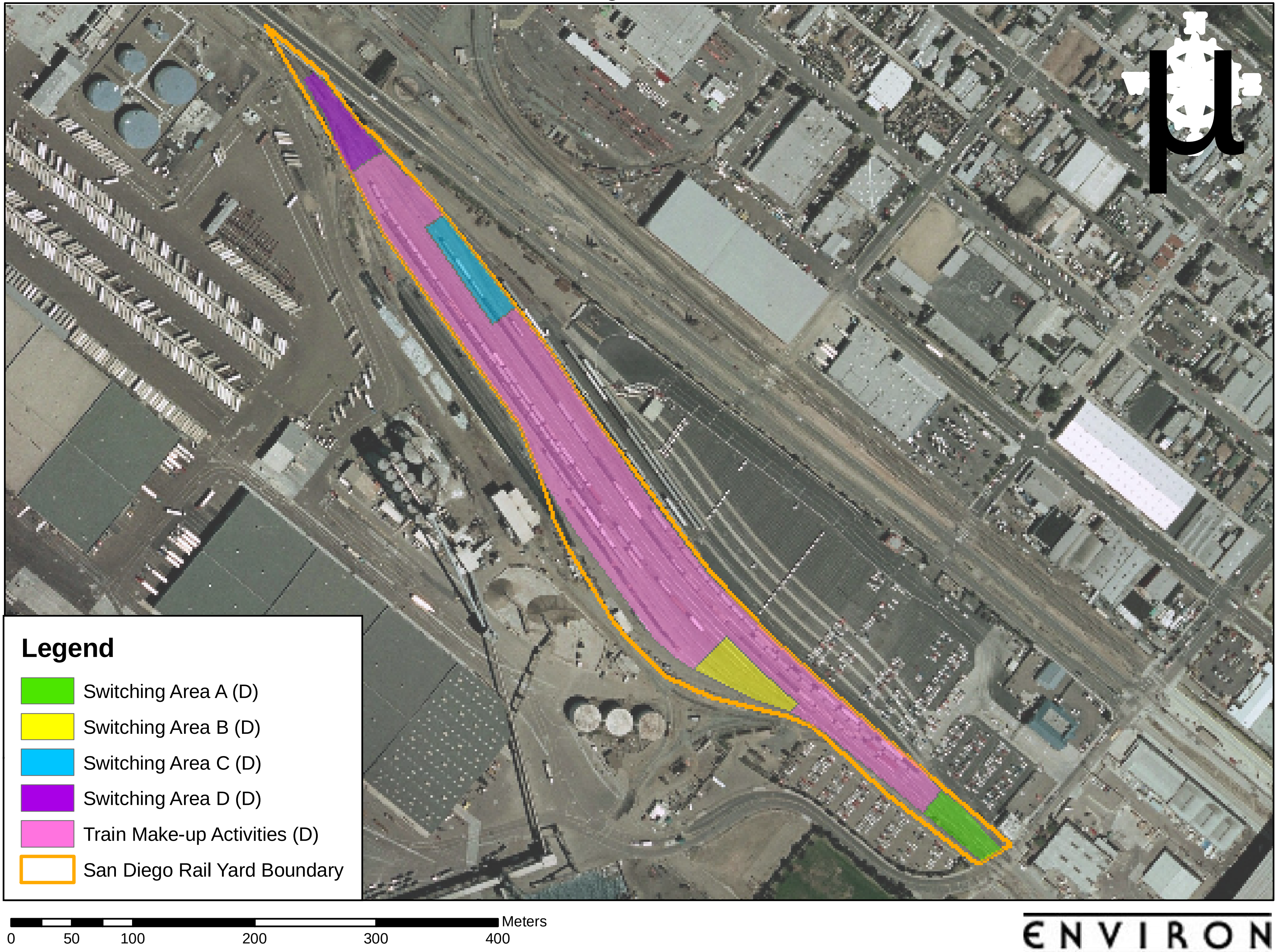


Figure 2-5: Stationary and Movement Locomotive Activities - BNSF Arriving-Departing Line Haul
BNSF San Diego Rail Yard
San Diego, California

ENVIRON

Figure 2-6: Off-Road Equipment - Track Maintenance Equipment and Transportation Refrigeration Units
BNSF San Diego Rail Yard
San Diego, California

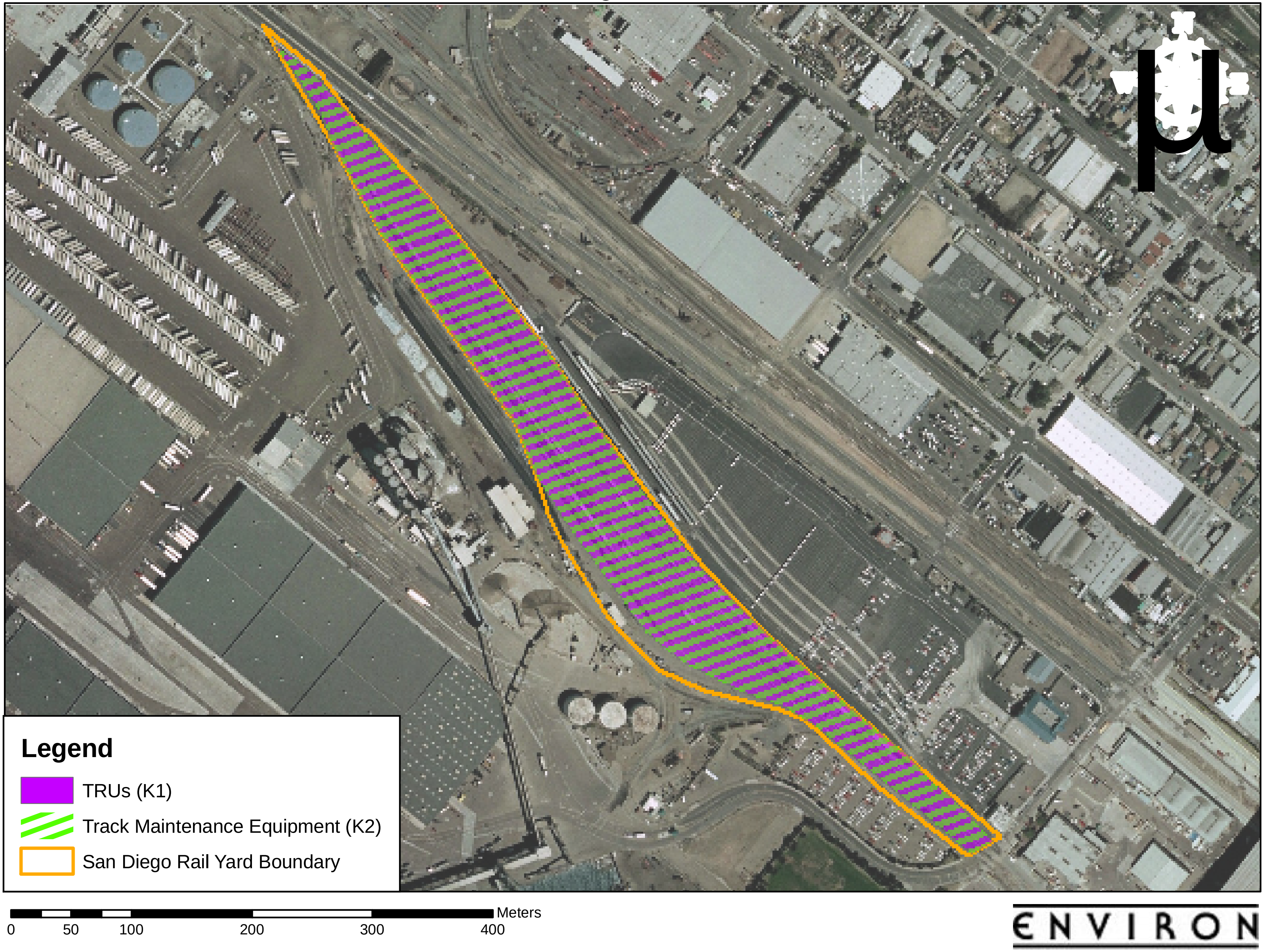


Figure 4-1a: Locations of Modeled Stationary Locomotive Sources - Idling at DTL Refueling Sites
BNSF San Diego Rail Yard
San Diego, California

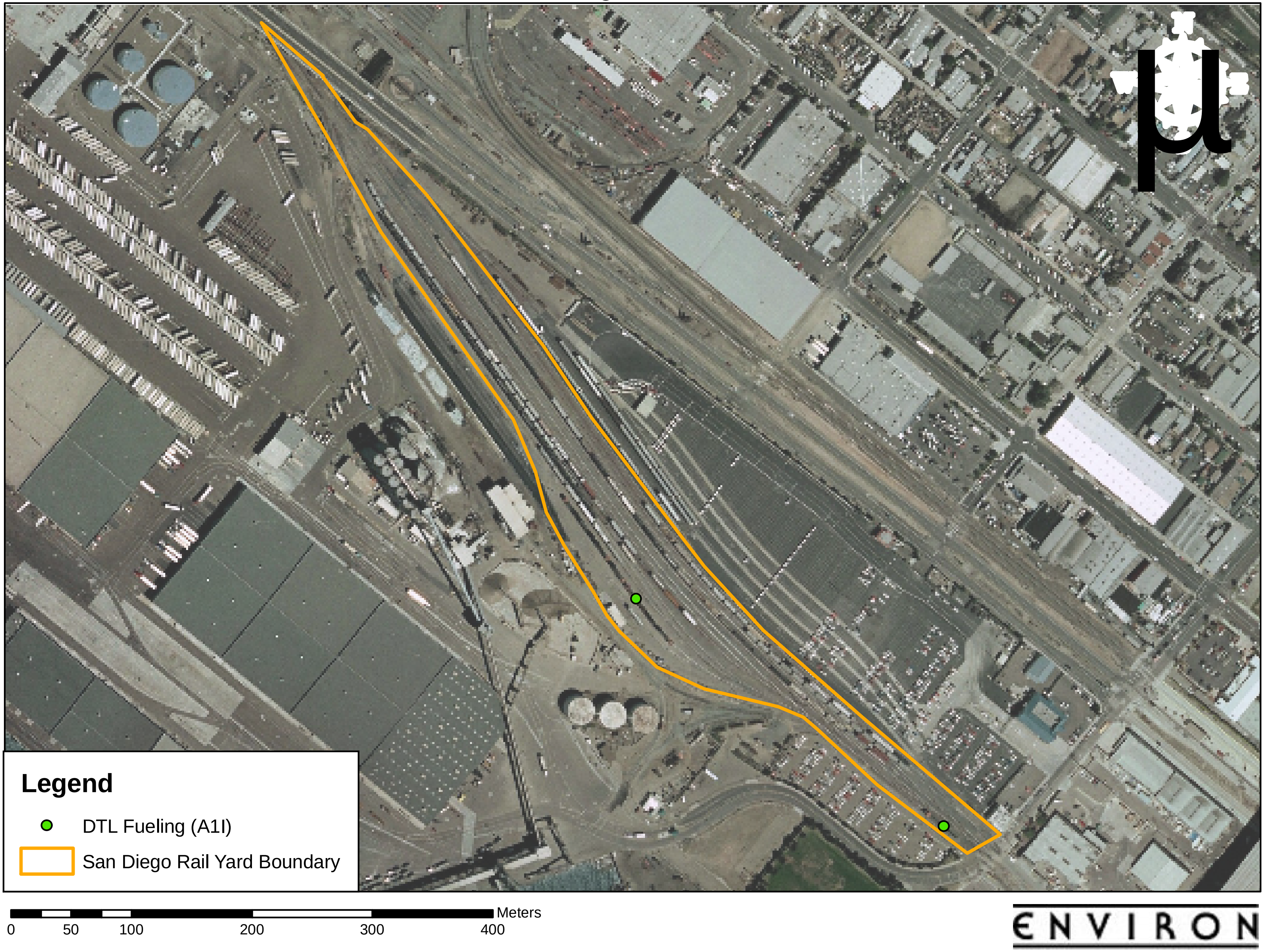


Figure 4-1b: Locations of Modeled Stationary Locomotive Sources - Switching
BNSF San Diego Rail Yard
San Diego, California

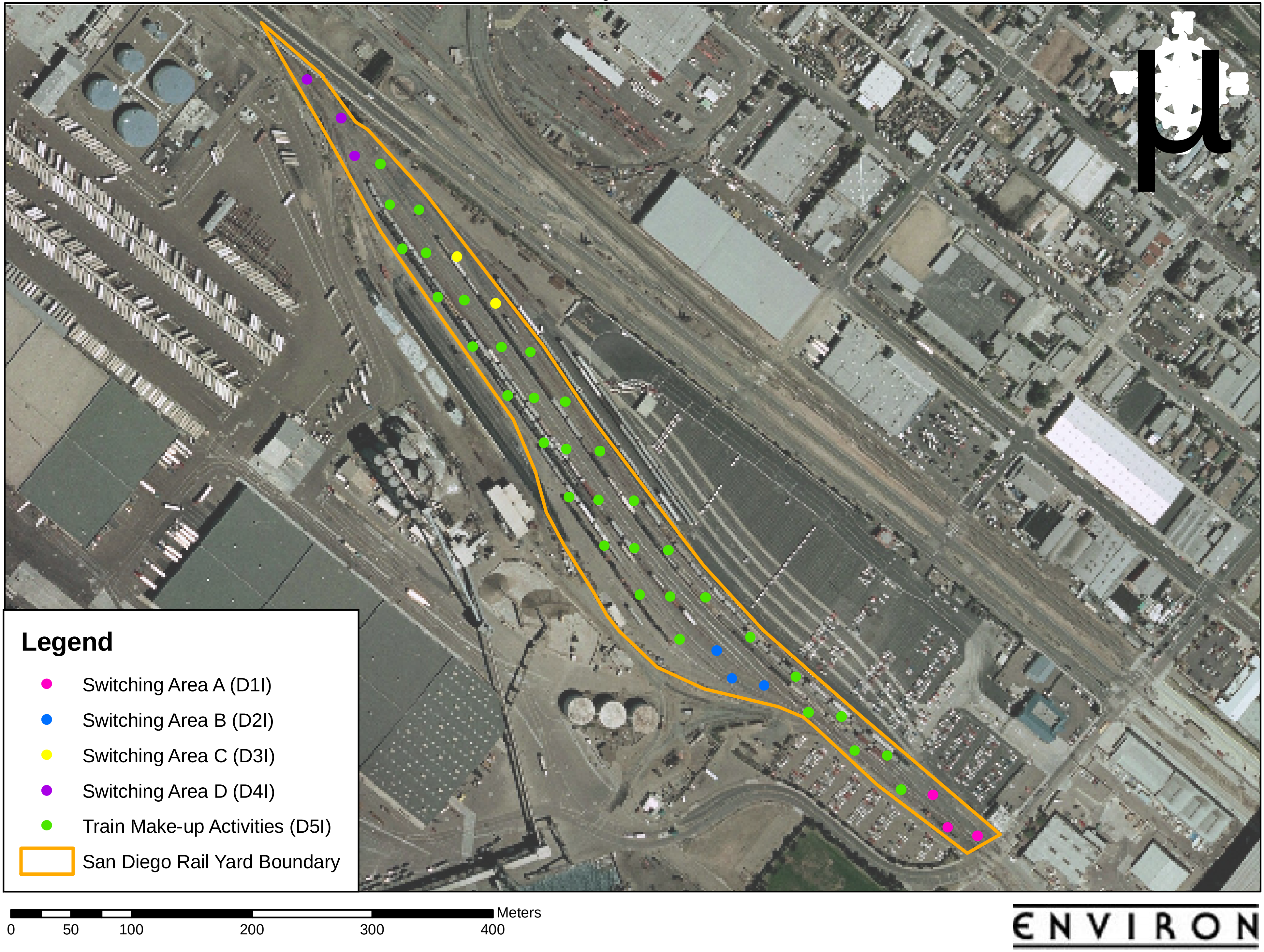


Figure 4-1c: Locations of Modeled Stationary Locomotive Sources - BNSF Arriving-Departing Line Haul
BNSF San Diego Rail Yard
San Diego, California

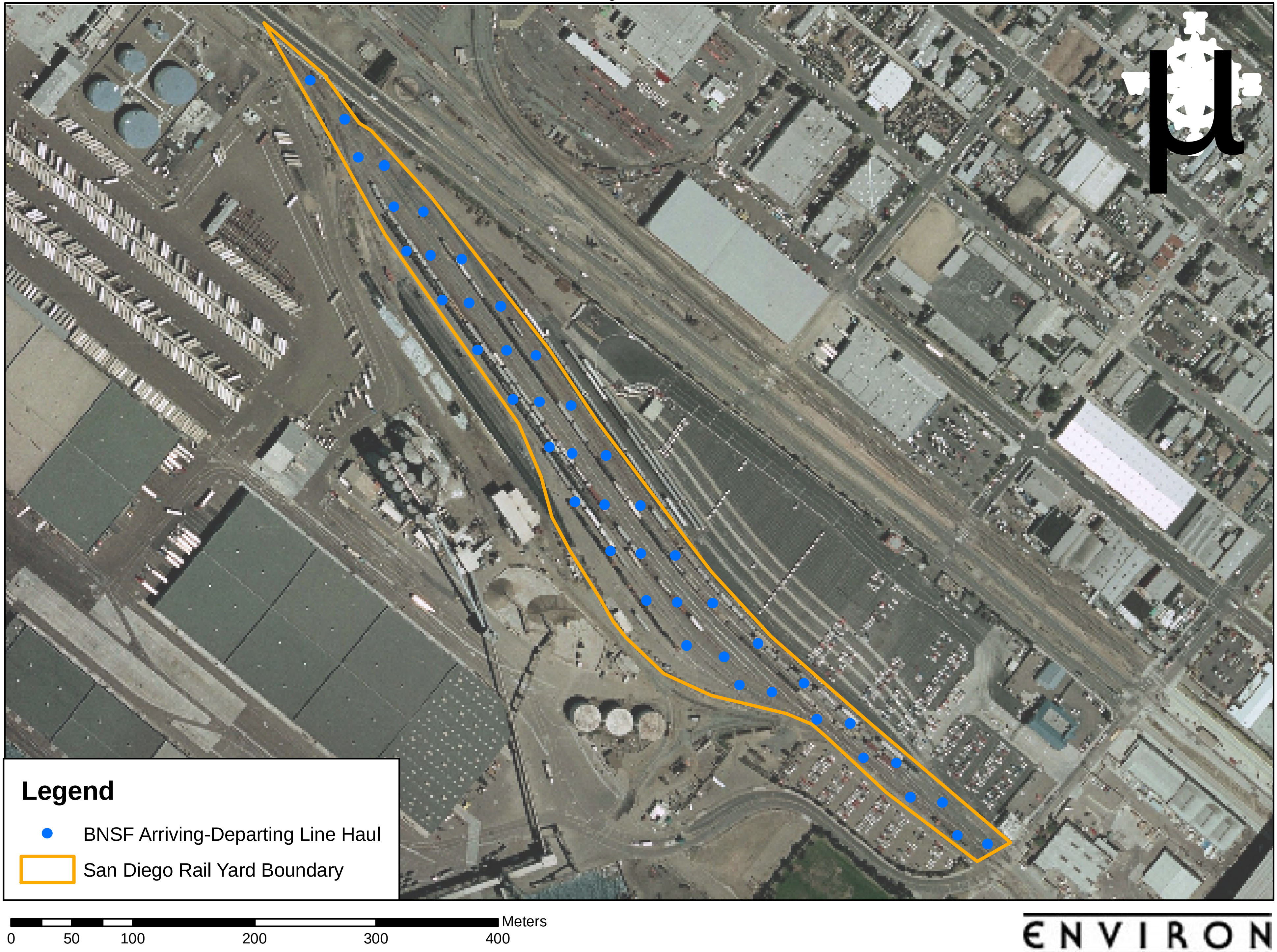


Figure 4-2a: Locations of Modeled Movement Locomotive Sources - Switching
BNSF San Diego Rail Yard
San Diego, California

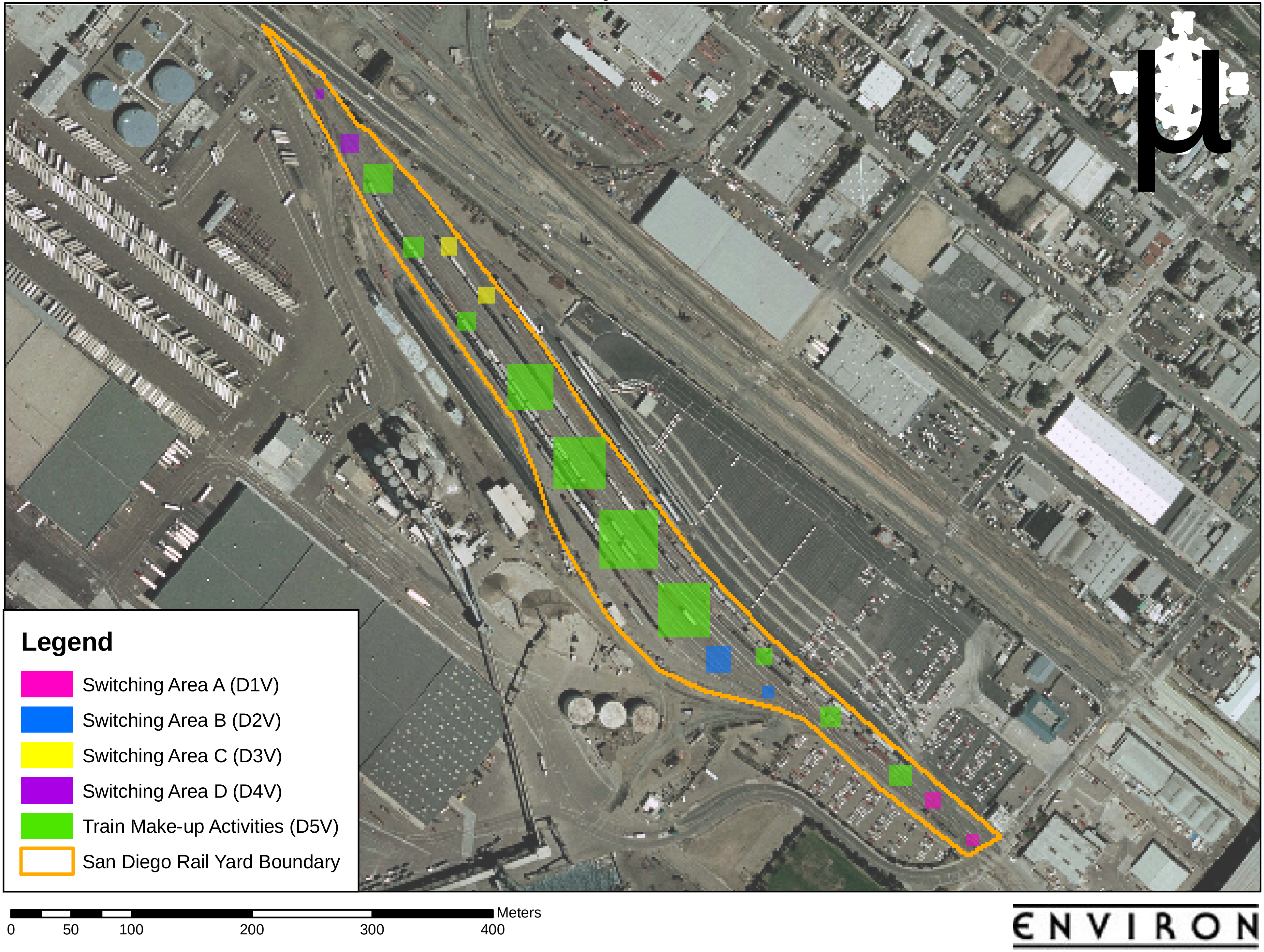


Figure 4-2b: Locations of Modeled Movement Locomotive Sources - BNSF Arriving-Departing Line Haul
BNSF San Diego Rail Yard
San Diego, California

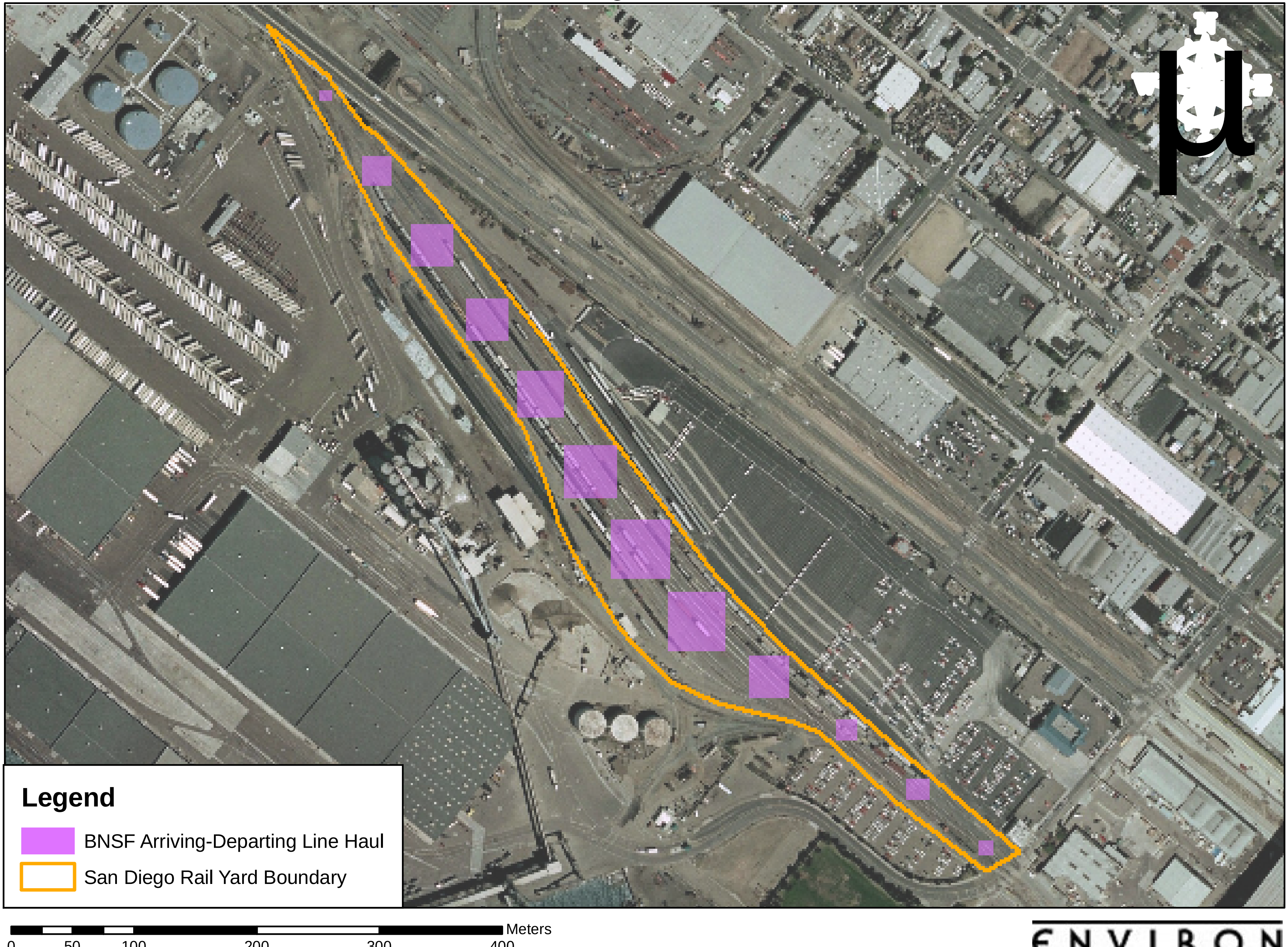


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Figure 4-3: Locations of Modeled On-Road Refueling Truck Sources
BNSF San Diego Rail Yard
San Diego, California

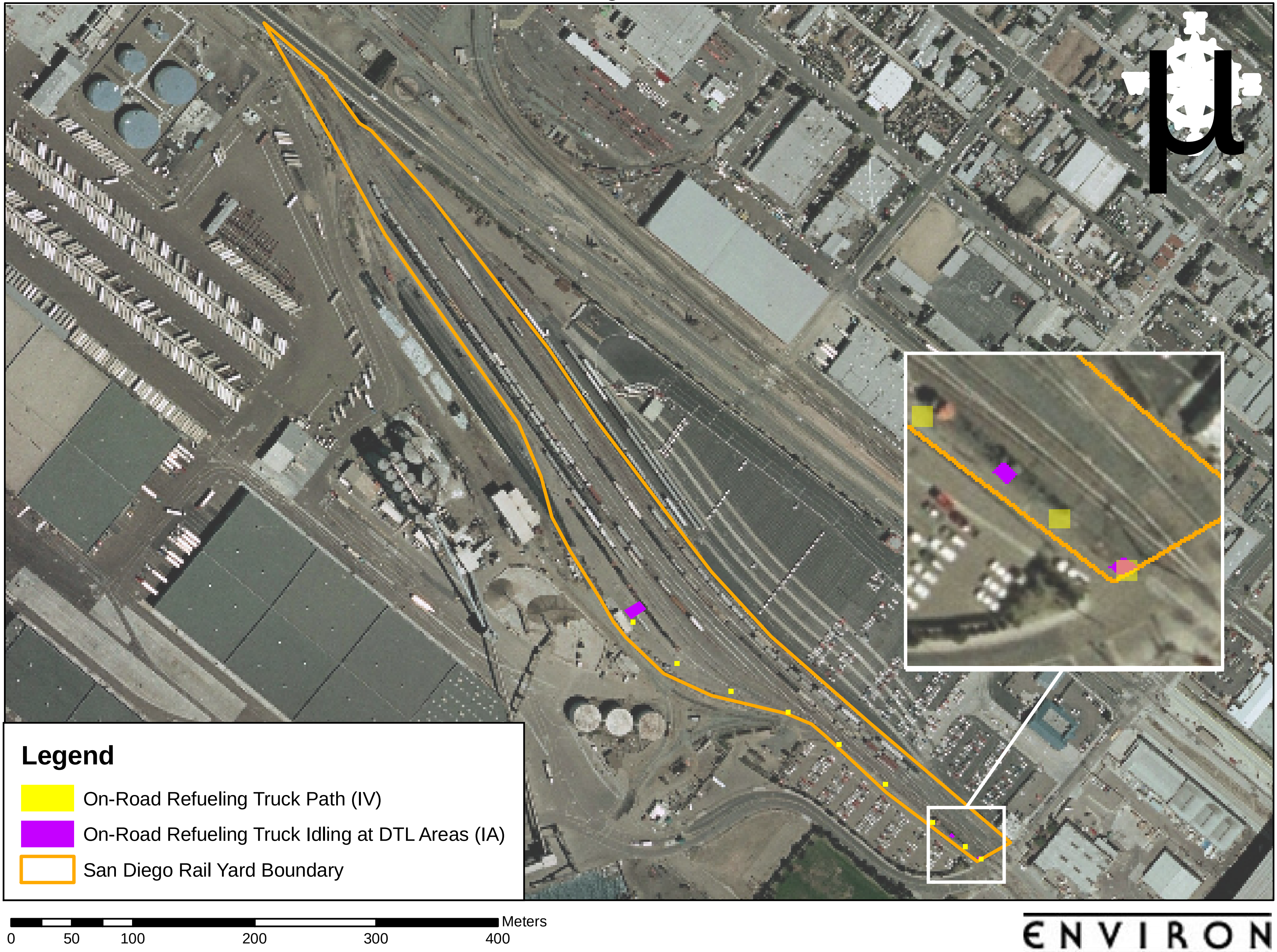

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Figure 4-4: Locations of Modeled Off-Road Sources - Transportation Refrigeration Units
BNSF San Diego Rail Yard
San Diego, California

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Figure 4-5: Locations of Modeled Off-Road Sources - Track Maintenance Equipment
BNSF San Diego Rail Yard
San Diego, California

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Figure 4-6: Sector Selection for Surface Parameter Analysis
BNSF San Diego Rail Yard
San Diego, California

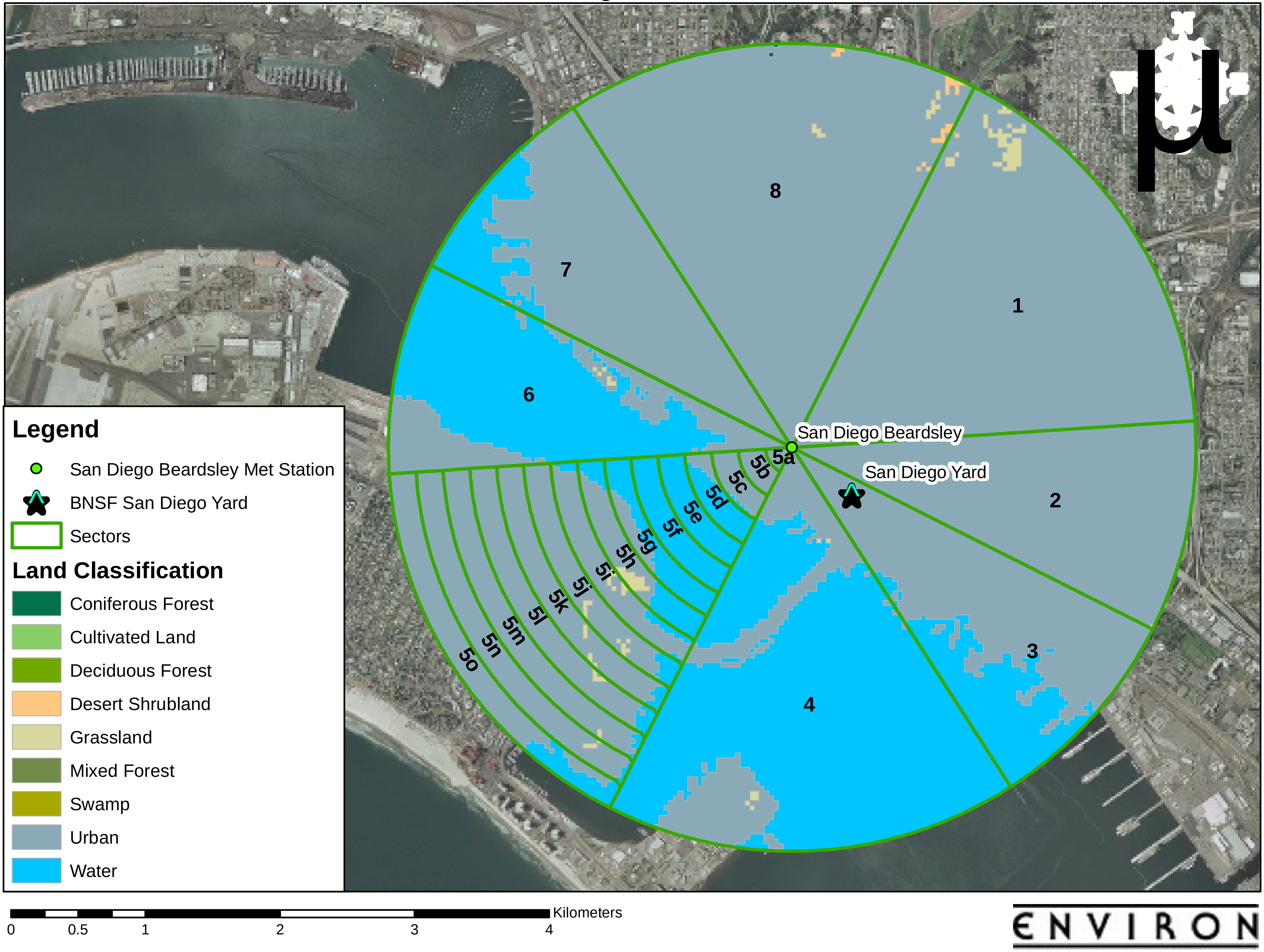

Figure 4-7: Locations of Buildings at or Near the Facility
BNSF San Diego Rail Yard
San Diego, California

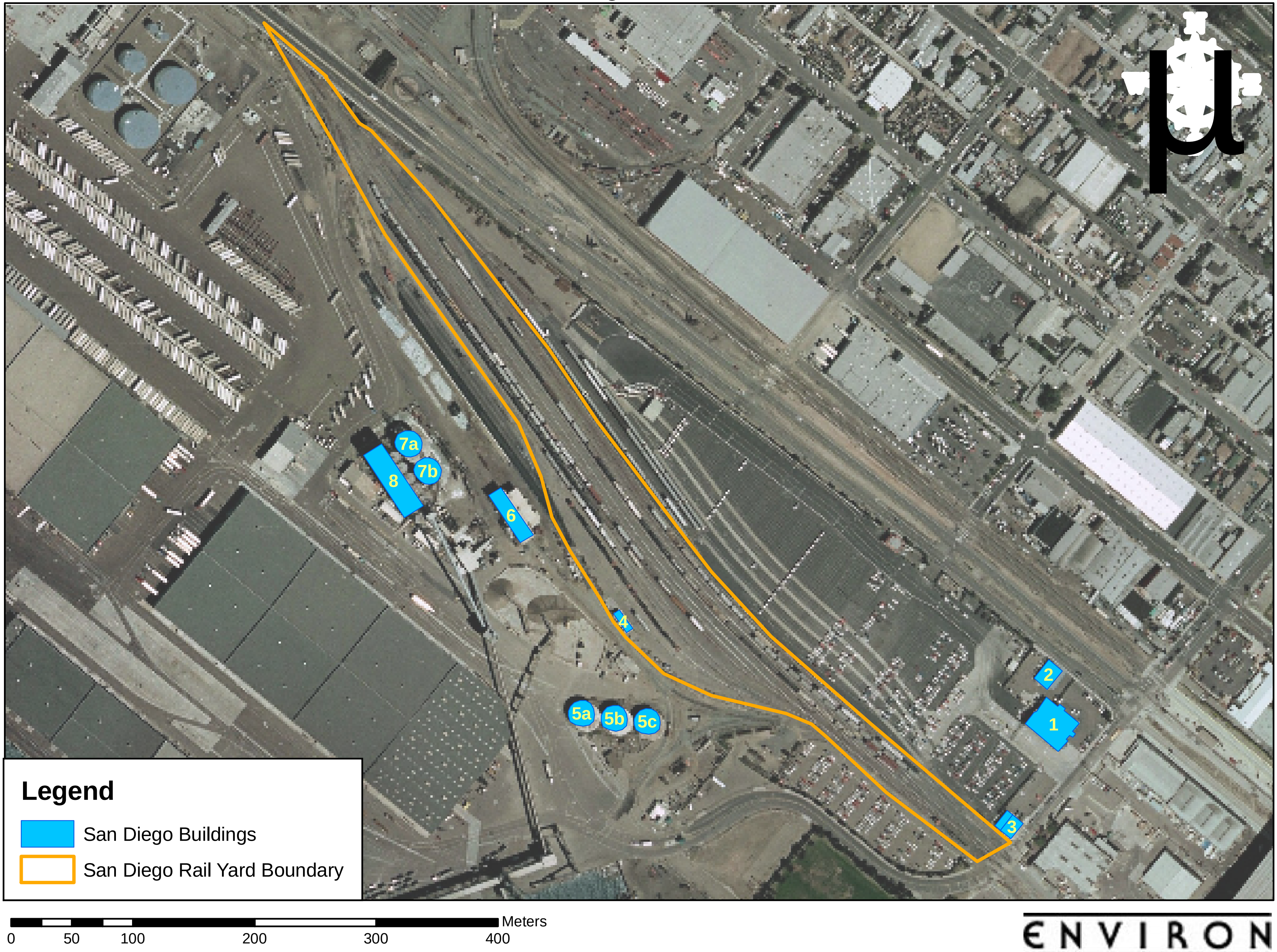

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Figure 4-8a: Land Use Within Three Kilometers of the Facility
BNSF San Diego Rail Yard
San Diego, California

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Figure 4-8b: Population Density Within Three Kilometers of the Facility
BNSF San Diego Rail Yard
San Diego, California

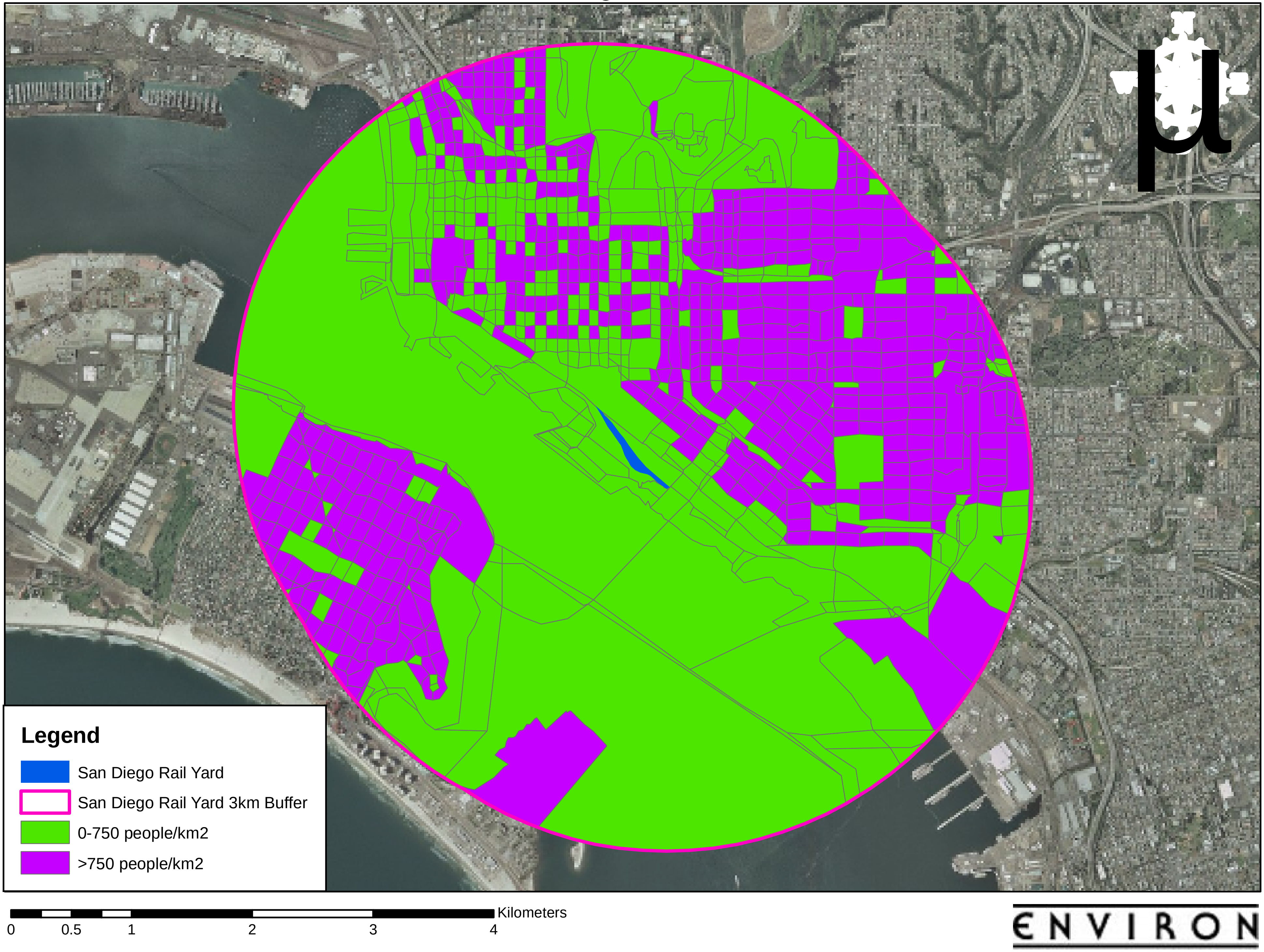

Figure 4-9a: Locations of Discrete Receptors in Coarse Grid
BNSF San Diego Rail Yard
San Diego, California

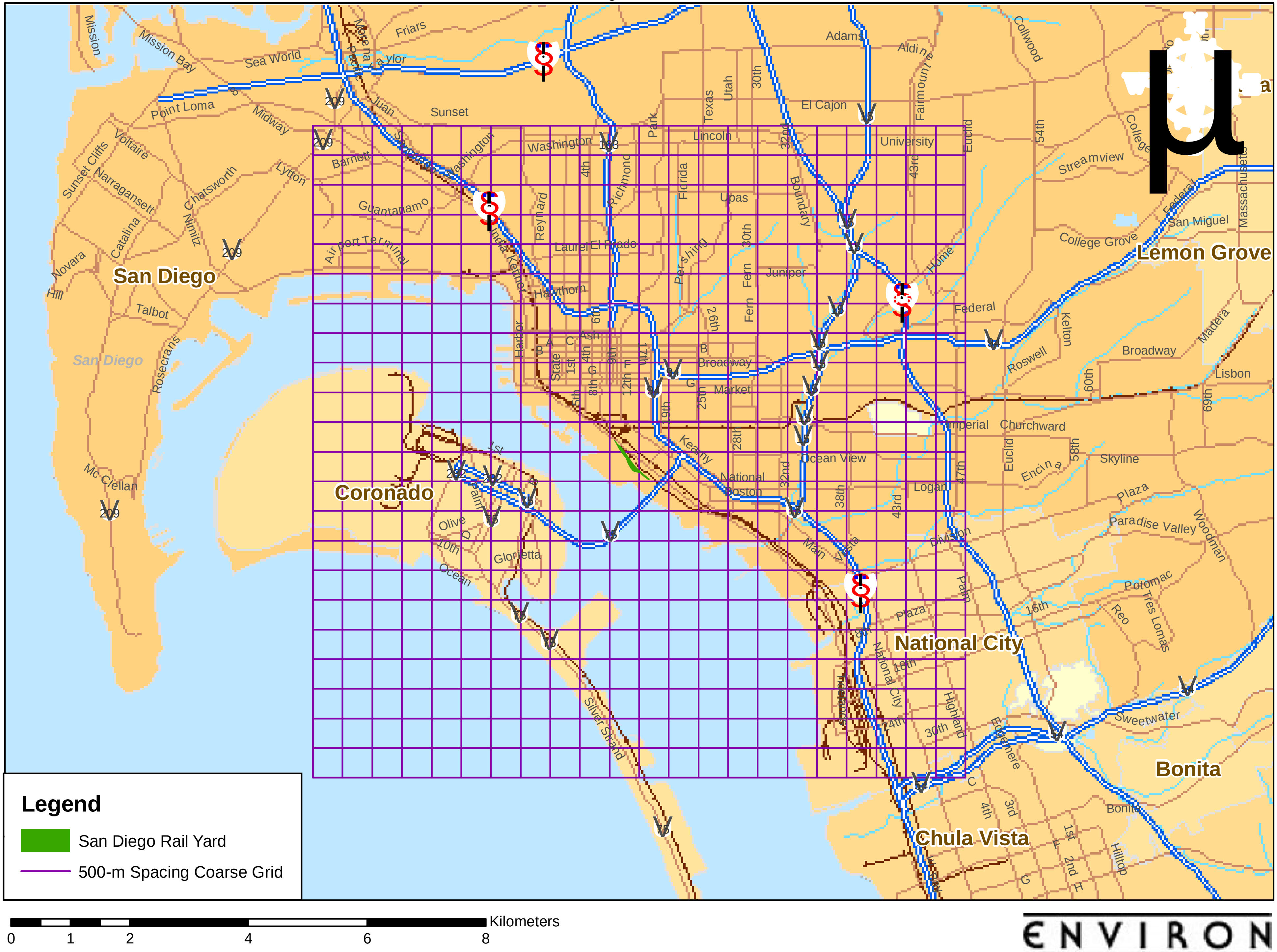

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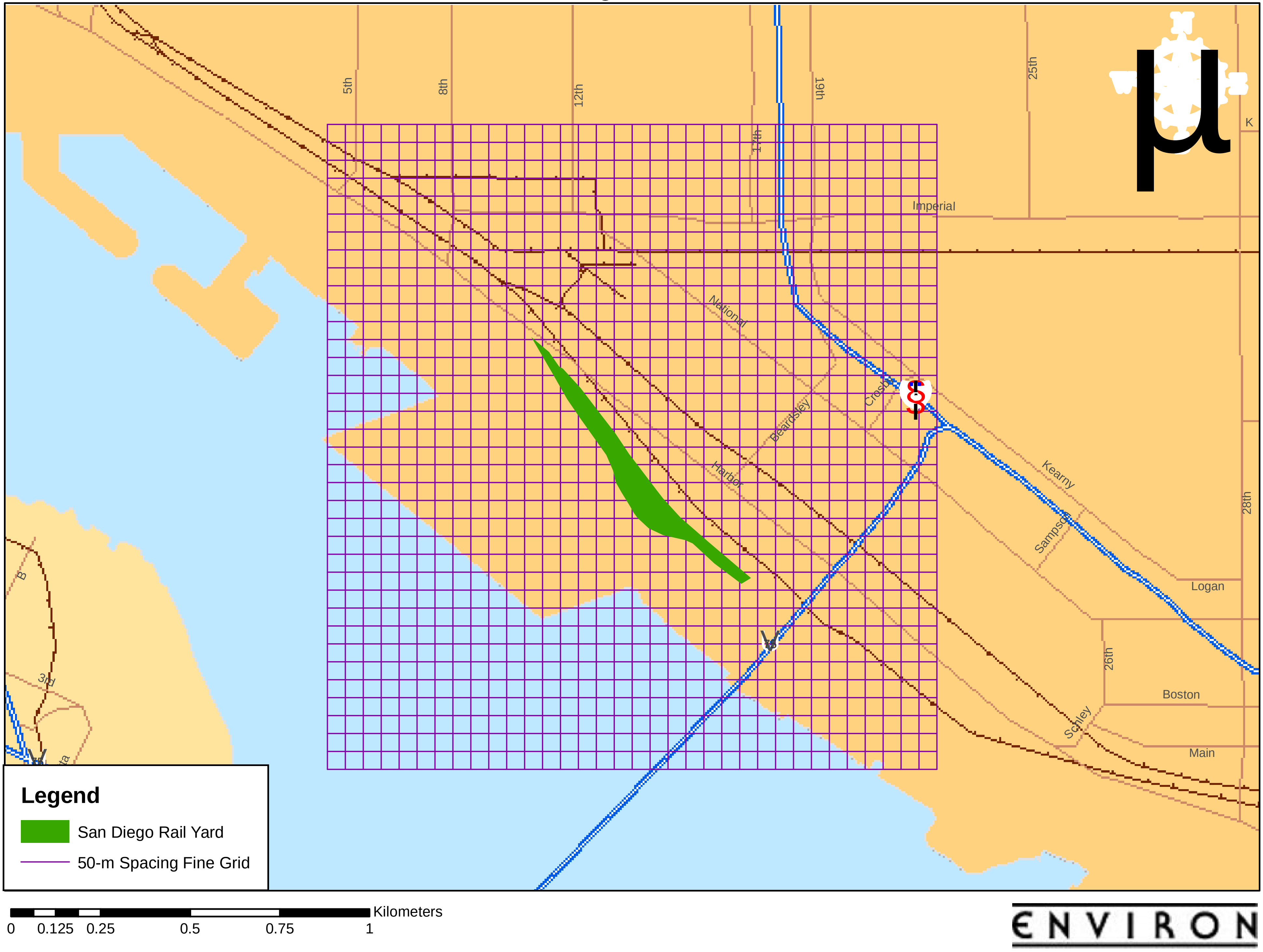
Figure 4-9b: Locations of Discrete Receptors in Medium Grid
BNSF San Diego Rail Yard
San Diego, California

Figure 4-9c: Locations of Discrete Receptors in Fine Grid
BNSF San Diego Rail Yard
San Diego, California



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